JOURNAL OF DAIRY SCIENCE

FEBRUARY, 1957

In this Issue:

A.D.S.A. Annual Meeting, Oklahoma A&M College
June 26 to 29, 1957

Key to Efficiency and Profits on Dairy Farms

Three Manufacturing Research Papers

Eight Production Research Papers

People and Events

Abstracts of Literature

ANNUAL MEETING
June 26-29, '57
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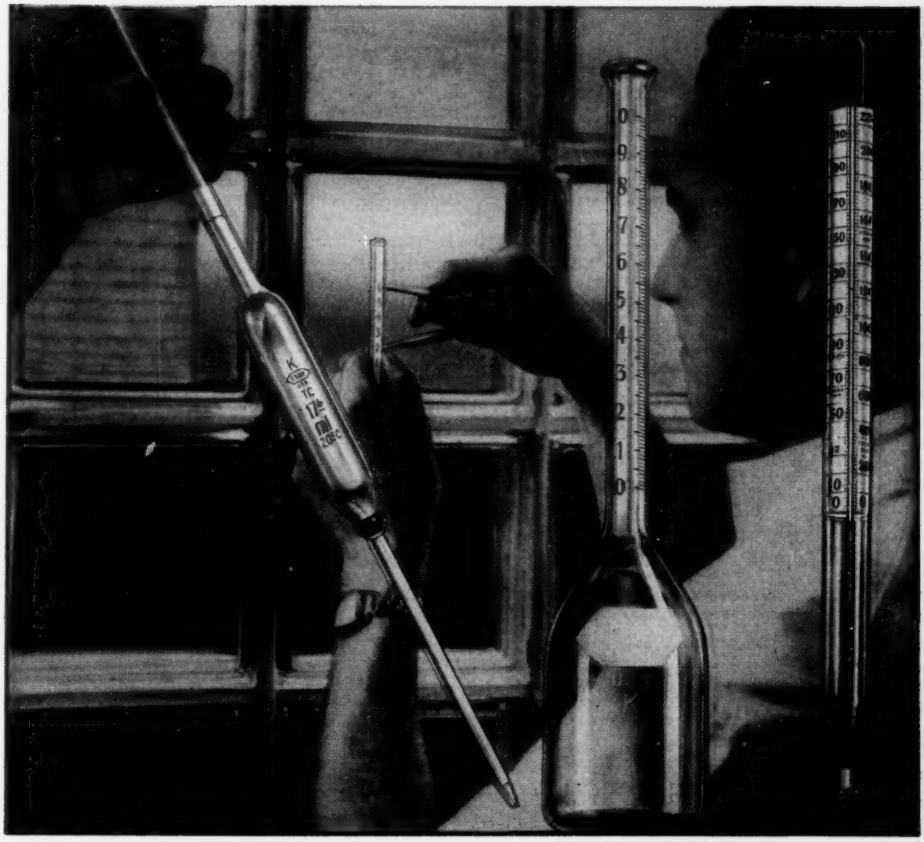

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PEOPLE and EVENTS
in the Dairy Science World

Plans Under Way For A.D.S.A. Meeting

Student Union, Oklahoma A & M College

Oklahoma A & M College, Stillwater, is looking forward to welcoming members of the American Dairy Science Association to their 52nd annual meeting, June 26-29, 1957. The meetings will center around the Student Union and Classroom Buildings, which are new air-conditioned structures.

This is the first time the annual meeting has been held in the Southwest and a large number of delegates and their families are expected to attend. An interesting program of entertainment is planned which includes a barbecue and an Indian dance.

This year Oklahoma is celebrating its 50th year of statehood and visitors may be interested in seeing some of the special events connected with this celebration.

FDA Starts Proceedings Against 4 Coal-tar Colors

The U. S. Food and Drug Administration (FDA) has started proceedings which could result in a ban on four coal-tar colors used in coloring butter, oleomargarine, and other food items.

FDA certifies coal-tar colors which may be legally used in foods. The law requires that an approved coal-tar must be harmless, regardless of how much is used.

The four colors involved in the new proceeding are FD&C Yellow No. 1, No. 2, No. 3, and No. 4.

No injurious effects on humans have been reported from any of the four colors involved. Animal studies, however, indicate that excessive amounts of these colors could cause injury.

In view of these findings, the FDA is required by law to initiate proceedings to remove the colors from the list of those which are certified for use in foods. The FDA gave notice of its action by publishing a proposed regulation in the Federal register which would require that the colors be deleted from the food list but would continue to be permitted in drugs and cosmetics for external application.

FDA also has published two proposed revisions of the definition of a coal-tar color as it appears in the color certification regulations. The first of these is the proposal to exempt from certification carbon black, caramel, and a number of colors derived from vegetable sources. A counter proposal offered by Hoffmann La Roche, Inc., Nutley, N. J., would exempt the same vegetable colors and "identical compounds produced by chemical synthesis without change of chemical structure." This proposal would exempt synthetic carotene from certification—a color used in butter and oleomargarine. Under the FDA proposal it would be certified.

AAAS Discusses "Grasslands in Our National Life"

Each year the program of Section O of American Association for the Advancement of Science (AAAS) is built around a general theme. "Grasslands in Our National Life" was the theme of the annual meeting of the Agriculture Section O of the AAAS which was held December 26-30, 1956, in New York City. The program was arranged by Section Chairman, H. B. Sprague, Pennsylvania State Univ., University Park. Ten sessions on papers on various aspects of the general theme were held. A.D.S.A. was one of the principal scientific societies that acted as a cosponsor of the program. A total of 67 papers were presented of which 15 were authored by A.D.S.A. members.

This year's theme was of general importance, as grasslands provide the principal source of feed for our livestock and an increase in their productivity is of practical and fundamental concern to the agricultural industry of this and other countries.

One session was held in cooperation with the Ecological Society of America in which data were presented on the extent that weather and degree of grazing influence yield and species composition in our native range grasses.

Two sessions were held in which general problems of forage production were discussed. Factors affecting seed production and seed-

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bed preparation were given and demonstrated in a colored movie film. The necessity for continuing research on the development of plants that are resistant to diseases and pests was demonstrated. The desirability of establishment and use of grasses and legumes in crop rotations in all climatic conditions was expressed. Grazing crimson clover, especially the reseeding variety, and other forage crops in the utilization of areas taken out of cotton production was described. Other speakers dealt with practical and technical problems of nitrogen and phosphorus fertilization and their effects on our grasslands.

The agricultural economists were the principal contributors to a session on economics of forages. Factors influencing grassland utilization on farms of different sizes and the most profitable cropping systems were discussed. The need for more precise data on the relative substitution values of various forages was pointed out by the economists, dairymen, and agronomists.

The session on the evaluation of forages was one of the most pertinent for many dairymen in attendance. In this session E. W. Crampton, McGill Univ., Toronto, Ont., Canada, presented evidence that the chemical analysis of a feed does not accurately estimate the animal performance of that feed. He developed the theory that the feeding value of a forage may best be measured by the voluntary dry matter intake of that material and presented evidence to support his contention.

R. F. Davis and A. M. Decker, Univ. of Maryland, College Park, presented data on the early cutting of alfalfa. Milk production, voluntary consumption, and percentage digestibility were greatest for alfalfa cut at the 1/10 bud stage when compared to full bud stage. Both these stages were far superior to alfalfa cut at the half-bloom stage. The total nutritive value per acre was slightly higher for alfalfa cut at the full bud stage than at the 1/10 bud stage and alfalfa cut at half-bloom stage was much less than alfalfa cut at either of the bud stages. Regrowth was not hindered by the early cutting.

M. E. McCullough, Georgia Experiment Station, Griffin, reviewed in detail a few recent experiments on factors affecting the feeding value of forages. He pointed out that investigations at Georgia and Clemson Agricultural College have indicated that winter pasture was of greater value than the energy it contributed in the case of milking cows.

J. T. Reid, Cornell Univ., Ithaca, N. Y., continued by indicating that the same amount of total digestible nutrients from different roughages produced a range in body weight gains from 0.3 to 2.4 lb./day. The advantages of evaluating forages on the basis of animal performance was emphasized and the use of indirect measurements to obtain the composition of the body weight gains was discussed.

J. A. Newlander, Univ. of Vermont, Burlington, presented data on a 7-year study of storage losses when forages were preserved by different methods. The losses were smallest for silage, largest for sun-cured hays and intermediate for mow-cured hay. Actual trials showed that the latter two had approximately the same total digestible nutrient content.

A review of ways to best utilize roughages for milk and meat production was given by A. D. Pratt, Ohio Experiment Station, Wooster.

Closely associated with the subject of evaluation of forages were two sessions on utilization of grassland products. The role that minerals exert in limiting the usefulness of grasses and grasslands for animal production and the influence of calcium, phosphorus, copper, and cobalt supplements in correcting these limitations was depicted by G. K. Davis, Univ. of Florida, Gainesville.

Studies on cellulose and related determinations on roughages in an attempt to obtain a more accurate evaluation of feeds through proper chemical analysis were presented by R. E. Ely, U.S.D.A., Washington, D.C.

Recent developments concerning estrogenic compounds found in roughages was reviewed by E. W. Cheng, Iowa State College, Ames.

Reports from the states of Florida and Washington indicated that 400 to 1,050 lb. of beef per acre were produced on irrigated pastures within these states.

The changes in protein, fiber, and lignum content of pasture crops during their growing season was presented by W. A. King, Clemson Agricultural College, Clemson, S. C.

Other sessions were devoted to related subjects such as forage problems on ranges, contributions made by meteorological and climatological sciences to grasslands and machinery and practices used in harvesting and preserving grassland crops.

The topics dicussed revealed the necessity of a cooperative and integrated effort on the part of the several diverse disciplines concerned with this field in order to obtain suitable, well-rounded, and complete answers to problems affecting grasslands. This type of meeting acquaints workers with projects in progress and the discussions show where more work needs to be performed.

"Liquor Gets the Boot"

"Liquor Gets the Boot," is the title of an editorial in the *Chicago Daily News* which discusses a new mode of entertaining customers now in use by Bauer & Black, a Chicago manufacturer of first aid and hospital supplies.

Conventions without cocktails is the rule at Bauer & Black. In place of stronger refreshments, conventioneers are served cold cuts of meat, cheese, bread, butter, coffee, and milk. And the *Daily News* reports that milk made the biggest hit.

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Louisiana Dedicates Dairy Building

New Dairy Science Building

The new dairy science building at Louisiana State Univ., Baton Rouge, which was dedicated in January, stands as a landmark of dairy progress in the state of Louisiana.

Some 350 visitors, representing each of the major dairy industries in the state, were on hand for the formal dedication ceremonies. Speakers included D. V. JOSEPHSON, Head of the Dairy Department, Pennsylvania State Univ., and vice-president of the A.D.S.A.; T. H. MIDDLETON, President of L.S.U.; J. N. EFFERSON, Dean of the L.S.U. College of Agriculture; and E. W. NEASHAM, extension dairyman at L.S.U.

The ultramodern brick structure which will house the manufacturing section of the Dairy Department, contains a modern dairy products processing plant and the latest facilities for a training in all the technical phases of the dairy industry.

A unique feature of the new building is that each of the processing operations is conducted in a separate room, thus eliminating interference with classes being held in other parts of of the building.

USDA Requests Bids For Packing Dairy Products

Offers to package and process nearly 15 million pounds of dairy products for domestic and foreign donation were requested by the USDA in February. For domestic donation bids were asked on repackaging about 12 million pounds of butter in 1-pound prints. This is the first butter scheduled for donation since late in the summer of 1956, when supplies in the government inventory were exhausted.

The USDA asked for bids to process 350,000 pounds of cheese and furnish 602,000 pounds of nonfat dry milk for the Hungarian program and 1,984,132 pounds of nonfat dry milk for the Italian program.

In addition, the USDA has announced the issuance of an authorization to India to finance the purchase of up to $133,000 worth of nonfat dry milk from United States suppliers under Title I, P.L. 480.

Louisiana Forms State Branch of A.D.S.A.

The Louisiana Division of the A.D.S.A., the first of its kind, was organized on January 10, 1957. The proposal to form a state branch of the A.D.S.A., in order to give better service at the state level, had been approved by the national association.

Membership is open to anyone belonging to the A.D.S.A., without additional cost. Officers were chosen from heads of dairy departments in colleges and experiment stations. The officers are H. S. NELSON, President; HAL BARKER, Vice-president; J. B. FRYE, JR., Secretary-Treasurer; CLYDE ROUGEAU, E. W. NEASHAM, JAKE C. BARMAN, JACK STANLEY, H. D. ELLZEY, and FORREST BAKER, directors.

It is hoped that the state branch will become affiliated with the Louisiana Academy of Sciences and meet with that group as an A.D.S.A. section.

Objectives suggested for the Louisiana Division are: (1) To affiliate all dairy science leaders in the fields of teaching, research, extension, industry and other fields of dairying; (2) To discuss mutual problems affecting the dairy industry of the state and to submit recommendations; (3) To provide members with new and modern advances affecting the dairy industry; (4) To provide technical information and advice to all dairy organizations and agencies related to the dairy industry; (5) To promote a closer and better relationship among the members of the association; and (6) To promote the general welfare of the dairy industry in Louisiana through educational activities and good public relations.

Brucellosis Committee Meets in Chicago

The National Brucellosis Committee, an organization devoted to the eradication of this costly disease, held its annual meeting February 14 at Chicago.

Topics and discussions included on the program were: Progress Report by C. K. MINGLE, Animal Disease Eradication Branch, Agricultural Research Service, USDA; "Swine Brucellosis" by KEITH MEYERS, Executive Secretary, National Swine Council; "Brucellosis Problems on Public Grazing Lands" by C. A. JOY, Chief, Division of Range Management, Forest Service, USDA and EDWARD WOOZLEY, Director, Bureau of Land Management, Department of Interior; Discussion of Interstate Regulations by R. J. ANDERSON, Chief, Animal Disease Eradication Branch, Agricultural Research Service, USDA; and others.

Sutton Working in India

T. S. SUTTON, Assistant Dean of Agriculture, Ohio State Univ., Columbus, is doing advisory work in Ludhiana, India, as a member of a mission to India sponsored by the U. S. Government in cooperation with Ohio State Univ.

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Recent Meetings

The 16th Annual West Virginia Univ. Dairy Short Course was held recently at Morgantown, attracting some 200 dairymen, county agents, and state and government workers from 10 states. Speakers included F. B. MORRISON, author of *Feeds and Feeding;* J. D. BURKE, Cornell Univ., Ithaca, N. Y.; STANLEY GAUNT, Univ. of Massachusetts, Amherst. Highlight of the course was a hay and silage show with W. H. HOSTERMAN and C. H. GORDON of the USDA acting as judges.

Oregon State College, Corvallis, in cooperation with Oregon Dairy Industries, held its 46th Annual Dairy Industries Conference in mid-February at Corvallis. Some 18 Oregon speakers both from the College and from industry took part in the program.

Approximately 45 high school, industry, and university representatives participated in a Career Conference sponsored by the Columbus Milk Distributors Assoc., Columbus, O., in cooperation with the Dairy Technology Department of Ohio State Univ., Columbus.

PAUL COOK, Production Manager, Fairmont Foods Co., presided at the dinner meeting which was followed by a film, "Opportunities Unlimited."

An illustrated lecture, "Factors Affecting Cottage Cheese Manufacturing," by W. L. SLATTER, Ohio State Univ., Columbus, was the feature of recent meetings of the four Dairy Technology Societies in Ohio—Maumee Valley, Northeastern Ohio, Central Ohio, and Cincinnati.

Twenty-three samples of vanilla ice cream obtained from 21 ice cream manufacturers were evaluated in South Carolina's fourth and largest ice cream clinic held in January.

W. H. E. REID, Univ. of Missouri, Columbia, and D. M. GRAHAM, Clemson, conducted the clinic.

A banquet attended by 35 industry leaders climaxed the first day. Professor Reid presented pictures and informative comments regarding recent dairy industrial developments in several European countries.

Speakers and their topics for the conference on the second day were: R. W. HENNINGSON, Clemson, "Ice Cream Ingredients"; J. T. LAZAR, JR., Clemson, "Automation in the Ice Cream Plant"; L. H. MINOR, Wyandotte Chemical Co., "Cleaning Material for the Ice Cream Plant"; J. E. WHITE, JR., The Borden Co., "Production Problems in Making Molded Ice Creams, Novelties, and Specials"; D. M. GRAHAM, Clemson, "Suggestions for Plant Judging of Ice Cream to Evaluate Competition"; and H. L. MITTEN, Creamery Package Mfg. Co., "The Care and Operation of Ice Cream Freezers."

Professor B. E. GOODALE, Clemson, was program chairman of the conference and W. L. ABERNATHY, JR., Executive Secretary and Treasurer of the South Carolina Dairy Assoc., was general chairman.

More than 100 people attended the Sixth Annual Dairy Industry Conference held recently at the Univ. of Arizona, Tucson.

Clemson News

Miss PAUTILHA GUIMARAES, field supervisor for the Animal Products Inspection Division of the Brazilian Ministry of Agriculture, has completed a course of study in dairy technology at Clemson College, Clemson, S. C.

Following a semester of course work, Miss Guimaraes worked with dairy extension people in South Carolina and with Clemson research specialists. She will visit Chicago, Univ. of Wisconsin, Univ. of Minnesota, Colorado A & M, and Washington, D. C., before returning to Brazil.

Florida Borden Award Goes to Holtsclaw

JAMES R. HOLTSCLAW has earned the 1956 Borden Award at the University of Florida, Gainesville. The award is presented to the senior in the College of Agriculture who has the highest grades among agricultural students who have taken at least two dairy courses.

The award consists of $300, a certificate from the Borden Co., and the placing of Mr. Holtsclaw's name on a bronze plaque in the Dairy Science Building.

A native of Carthage, Ill., Mr. Holtselaw was the recipient of the 1955 Virginia Dare Award. He is married, has two children, and is a veteran of the U. S. Navy.

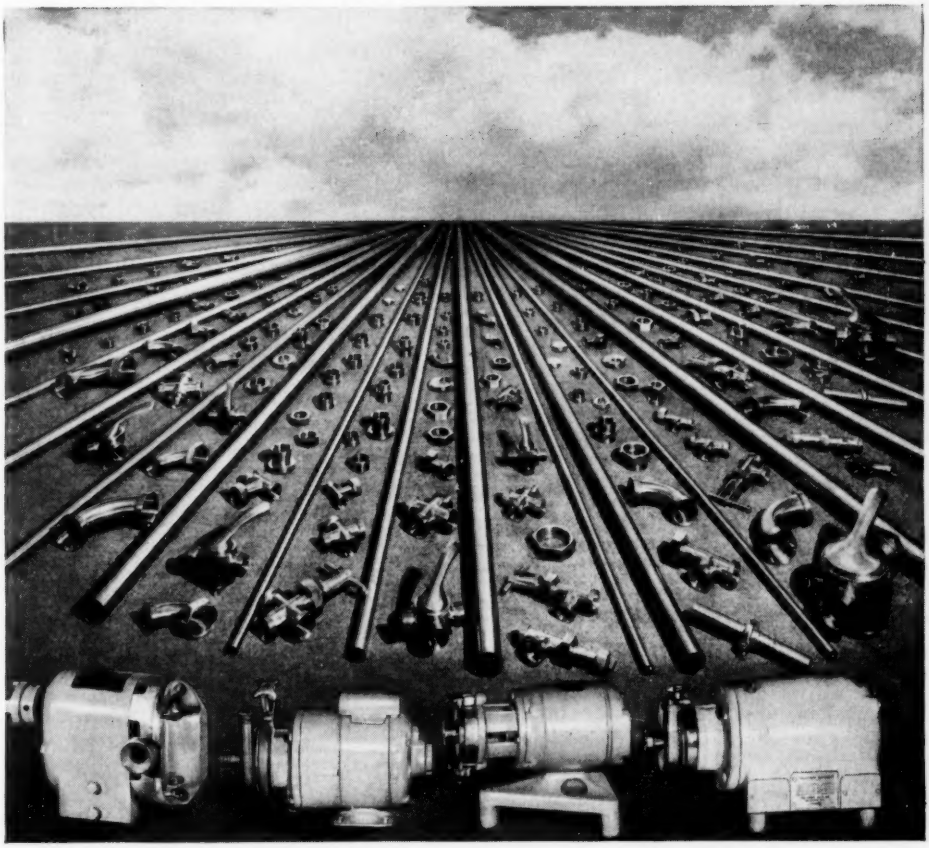
Journal Circulation Girdles the Globe

Increasing world interest in dairying and dairy science is indicated by the fact that *The Journal of Dairy Science* now circulates in nearly 100 foreign nations inside and outside the "Iron Curtain."

Each month copies of the Journal are shipped to foreign countries from Africa to Zanzibar. Among the "far-away" places and strange-sounding names" are Czechoslovakia, Indonesia, Luxembourg, Eire, Egypt, Thailand, Yugoslavia, Wales, and Fiji.

Countries receiving more than 25 subscriptions each are Africa, Australia, Canada, England, France, Holland, India, Italy, Japan, most countries of South America, and U.S.S.R.

The current mailing list of the Journal actually has more subscriptions outside of the U.S. than it has at home. With its circulation growing month by month in both domestic and foreign subscriptions, the Journal seems destined to continue spreading research results throughout the world.



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SALES AND SERVICES IN 58 CITIES—U.S. AND CANADA

Recent Deaths

Memorial services were held Dec. 30, 1956, in Madison, Wis., for ALBERT J. CRAMER, 66, who died Dec. 22 in Santa Monica, Calif., after a brief illness.

A member of the Univ. of Wisconsin faculty from 1919 until he retired as Professor Emeritus in Nov., 1955, Mr. Cramer was honored by the A.D.S.A. at the 50th Anniversary Meeting in June, 1956.

Mrs. B. W. HAMMER, wife of B. W. HAMMER, Professor Emeritus, Iowa State College, Ames, died in January at Sarasota, Fla.

THOMAS HENRY BINNEY, 63, Associate Chief of the Creamery License Division, Purdue Univ., West Lafayette, Ind., died Dec. 24, 1956, of a heart attack.

Mr. Binney received his B.S. and M.S. degrees from the Univ. of Wisconsin, Madison. He joined the Dairy Department at Purdue in 1923 and was first made Assistant Inspector in the Creamery License Division and later Associate Chief of the Division, a position he held until his death.

JAMES W. LINN, 65, retired Dairy Extension Specialist, Kansas State College, Manhattan, died Jan. 6, 1957, after a lengthy illness.

Mr. Linn received his B.S. degree at Kansas State in 1915 and joined the staff in 1924. He retired in 1954.

As a pioneer in Ayrshire breeding, he received citations from that breed's association as a judge and classified and had served as association president. In 1950 he was recognized by Epsilon Sigma Phi, honorary extension fraternity, for outstanding extension work. Mr. Linn was the first dairy leader in Kansas to receive recognition by the Interbreed Dairy Council for outstanding contributions; he conducted the dairy column of the *Weekly Star Farmer* for many years; and he was an early promoter of 4-H and D.H.I.A. work.

A student loan fund has been established in his memory for advanced dairy students who have been in 4-H club work.

News from Research Lab. Div. of National Dairy Products Corp.

The National Dairy Research Laboratories, Inc., has recently become an operating division of the National Dairy Products Corp. The name of the organization has been changed to Research Laboratories Division, National Dairy Products Corp.

ARNOLD H. JOHNSON, President of the Division, was elected chairman of the Dairy Research and Marketing Advisory Committee of the USDA. Dr. Johnson has been a member of the committee since 1954.

BYRON H. WEBB, Director of Research, has been selected as chairman of the Dairy Task Group of the President's Appointed Bipartisan Commission on Increased Industrial Use of Agricultural Products.

Four Research Laboratories Division scientists presented papers at recent scientific meetings. They are SAMUEL M. WEISBERG, Chief of the Animal Feeds and Nutrition Laboratory, "The Effect of Milk Products on the Eating Quality of Broilers," Texas A & M; FRANKLIN W. BARBER, Chief of the Fundamental Research Laboratory, "New Laboratory Procedures for Bacterial Testing-Membrane Filter Techniques," Milk Industry Foundation meeting, Atlantic City, N. J.; HENRY R. ROBERTS, Leader of The Chromatography Group, "A Rapid Horizontal Paper Chromatographic Method for the Quantitative Analysis of Lactose and Monoses in Lactose Hydrolysates," American Chemical Society meeting, Atlantic City; and H. GORDON HARDING, Leader of the Sanitary Chemistry Section, "A Review of Milk Waste Treatment Methods," annual conference of the Pennsylvania Sewage and Industrial Wastes Assoc., University Park, Pa., and on "Modern Dairy Cleaning Compounds," Philadelphia Dairy Technology Society meeting.

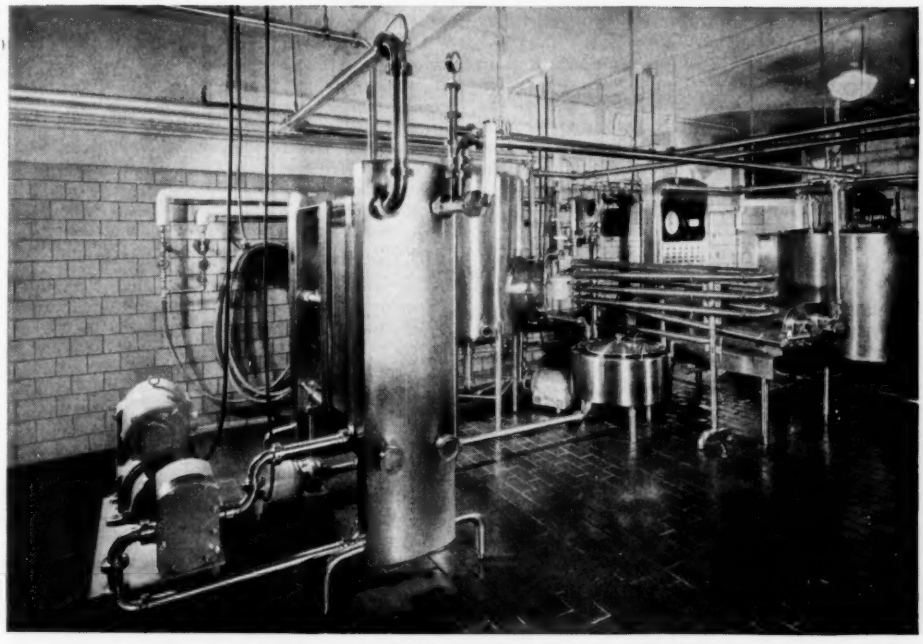
A.D.S.A. Officers Attend Southern Meeting

A.D.S.A. President C. F. HUFFMAN, Michigan State Univ., East Lansing, and A.D.S.A. Director R. E. HODGSON, USDA, Beltsville, Md., attended the annual meeting of the Southern Division of A.D.S.A. held in early February at Birmingham, Ala. The meeting was held in conjunction with the Southern Agricultural Workers Convention.

Washington State News

A. O. SHAW has resumed the chairmanship of the Department of Dairy Science of the State College of Washington, Pullman, after serving as Chief Advisor of a staff group representing the State College in an intercollege exchange program with the University of the Punjab, Pakistan.

He was assigned to the Punjab College of Animal Husbandry and Veterinary Science located at Lahore, Pakistan. Dr. Shaw also attended the World's Dairy Congress in Rome and visited dairy installations throughout Europe. H. A. BENDIXEN served as acting chairman of the department during the absence of Dr. Shaw.



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N. S. GOLDING, Professor Emeritus of Dairy Science, attended the World's Dairy Congress in Rome. He also visited dairy installations in Europe and his native land of England. Dr. Golding currently is continuing his studies under a grant from the American Dairy Association on the development of a subsurface centrifugal hydrometer for determining the nonfat solids content of milk.

J. O. YOUNG, on leave from the Department of Dairy Husbandry, Oregon State College, Corvallis, is enrolled for graduate studies toward the Ph.D. degree at the State College of Washington, Department of Dairy Science.

Borden's Promotes Davis, Estell

The promotion of DAVID A. DAVIS, manager of Borden's Moores & Ross, Columbus, O., to vice-president of Borden's Dairy and Ice Cream Co., has been announced by NORVAL D. GOSS, president of Borden's Dairy and Ice Cream Co. and chairman of Borden's Mid-West District.

Simultaneously, ANSEL Z. ESTELL was named to succeed Mr. Davis as manager of Borden's Moores and Ross. Mr. Estell has been associated with the company since 1935 and served recently as assistant to Mr. Davis.

A native of Columbus, Mr. Davis graduated in dairy technology from The Ohio State Univ. He joined Borden's Moores and Ross in 1936, became production manager in 1948, and manager in 1949. He is a past president and trustee of the Columbus Milk Dealers' Association, a director of the Ohio Ice Cream Manufacturers' Association, and treasurer of the Columbus Milk Council.

Mr. Estell graduated from The Ohio State Univ. in 1935 with a major in dairy technology. Following graduation, he joined Borden's at Portsmouth, and during the next 13 years held key positions in production and sales at Borden plants in Newark, Chillicothe, and Columbus.

Harvey W. Wiley Award Announced

The Association of Official Agricultural Chemists has announced the establishment of the HARVEY W. WILEY Award for the development of analytical methods.

This annual award of $500 will be given to the scientist or group of scientists who have made outstanding contributions to the development and establishment of methods of analysis of those products — soils, fertilizers, pesticides, plants, feeds, foods, colors, cosmetics, drugs — for which provision is made in *Official Methods of Analysis of the Association of Official Agricultural Chemists*, as well as for methods in general analytical chemistry.

Nominations for the award may be made by any interested person, and nomination materials should be sent to the A.O.A.C. Secretary, Box 540, Benjamin Franklin Station, Washington 4, D.C., before April 1 of the year in which the award is to be made. Each person may make only one nomination. Materials, of which eight copies should be submitted, must contain a biographical sketch of the nominee, specific identification of the work on which the nomination is based, and an appraisal of the nominee's accomplishments. The first award will be given in 1957.

NDC Appoints Whitlock

GAYLORD P. WHITLOCK has been appointed Director of the Health Education Service of the National Dairy Council. He will serve also as coordinator of the activities and services of the following NDC departments: Affiliated Unit Service, Library, Materials Development, Program Service, and Nutrition Research.

As Director of Health Education Service, Dr. Whitlock will work closely with the program personnel of NDC's 73 affiliated dairy council units to aid them in the community nutrition education programs they conduct in 36 states throughout the nation.

Widely known in the food technology field as a public speaker and author of numerous professional papers, Dr. Whitlock has been associated with Merck and Co. as technical nutritionist and sales counselor.

Dr. Whitlock was born on a dairy farm in Southern Illinois and graduated from Southern Illinois Univ., Carbondale. He earned his master's and doctor's degrees at Pennsylvania State Univ., University Park, where his studies were concerned with the dairy industry, education, and nutrition science.

NDC Announces Two Nutrition Grants

Two nutrition research grants have been announced by the National Dairy Council (NDC). One grant is for renewal of a project already in progress; the other is for a new study.

The continued project is one being directed by L. E. HOLT JR. at New York Univ., New York City, on a study of the essential amino acid requirements for infants.

The new research project, under the direction of ERCEL S. EPPRIGHT, Iowa State College, Ames, is a cooperative project with the dental school of the University of Iowa, Iowa City. This study seeks to determine the effect of various foods on dental health.

Financing for the two projects has been drawn from funds allocated to the NDC annual budget by the American Dairy Assoc. for support of research.

APHA Methods Manual to Be Revised

LUTHER A. BLACK, chairman of the American Public Health Assoc. (APHA) subcommittee on standard methods for the examination of dairy products, has announced that methods

material is being revised for the 11th edition. The final draft is scheduled for publication by the summer of 1958.

Where to Send It

Throughout the year many members and subscribers may have occasion to correspond with the Association about subscriptions to *The Journal of Dairy Science.*

So that all inquiries may be given prompt attention and quick action, the Association requests that you make a note of this brief outline of "where to send it."

Membership correspondence (including material relative to members' subscriptions to the Journal) — The American Dairy Science Association, c/o H. F. JUDKINS, Secretary-Treasurer, 32 Ridgeway Circle, White Plains, N.Y.

Nonmember subscription correspondence — The Journal of Dairy Science, c/o The Garrard Press, 119-123 West Park Avenue, Champaign, Illinois.

Illinois Meeting to Discuss Automation

More than 25 talks and discussions will be conducted at a Conference on Automation in the Dairy Industry to be held at the Univ. of Illinois, Urbana, March 26-28.

The three-day meeting, sponsored by the Department of Dairy Technology and the Division of University Extension at Illinois, will feature as one of its main topics, "Standard Dairy Processing Operations and Instruments Necessary for Automation."

Other discussion topics concerned with automation in the dairy industry will include "Planning Milking Parlors, Milking Barns, and Milk Houses for Automation;" "Spray Cleaning of Bulk Tank Trucks;" "Economics Involved in Bulk Handling vs. Can Handling;" "Modern Compress and Hardening Tunnels;" "New Control Systems for New Processes;" "Continuous Pasteurization of Ice Cream Mix;" "Gearing Plant Maintenance for Automation;" "High Temperature Mix Pasteurization;" "High Temperature Milk Sterilization;" and "Making Your Products Available Around the Clock by Automatic Merchandising."

Studies of School Milk Program

Two studies—one at the Univ. of Wisconsin and one by the USDA at St. Louis—indicate that the Federal School Milk Program will greatly increase milk consumption by children.

Univ. of Wisconsin agricultural economists have found that school children will drink more milk during school hours if the price is lowered; but they'll also drink more if milk is made available more often—even when the price remains unchanged.

These are results of a pricing experiment conducted in Milwaukee and Madison under

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the direction of Univ. of Wisconsin economists HUGH COOK, H. W. HALVORSON, R. L. SUCHER, and DONALD TURNER, and former state school lunch administrator GORDON GUNDERSON. The results of this study are being used during the present school year to establish subsidies to be paid to schools throughout the nation in the Federal School Milk Program.

USDA researchers have reported that St. Louis, Mo., school children have sharply increased their consumption of milk since the adoption of the Special School Milk Program. The Agricultural Marketing Service reported that milk consumption increased 50 per cent in St. Louis elementary schools and doubled in the city's high schools. These results were recorded within a year after the adoption of the Federal School Milk Program in the city's schools.

Concentrated Milk Survey

Fresh concentrated milk should find a good market among the nation's consumers if it sells for a little less than fresh whole milk, Univ. of Wisconsin agricultural economists found in a recent survey at Madison and Beloit.

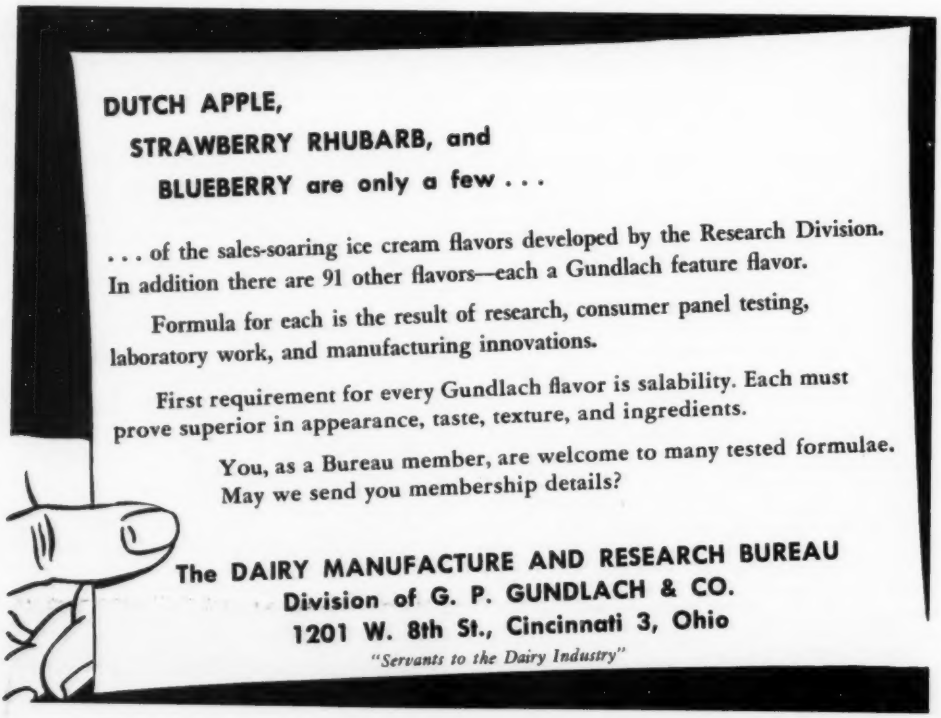
In a study of 919 families, the researchers found that half of the families would substitute the University's new three-in-one milk concentrate for their regular milk purchases if it sold for two cents a quart less.

If the concentrate were six cents less than fresh milk, 76 per cent of the families would switch to it. Only 22 per cent would not switch for any price. All comparisons were made with regular milk assumed to be 20 cents a quart. Conducting the survey were HUGH COOK, H. W. HALVORSON, HUGH MOORE, JOHN MOORE, and DONALD TURNER.

Popularizing Results of Scientific Research

A Guest Editorial

A complaint heard from some quarters is that the results of research published in scientific journals are presented in such a manner that one who is not an expert in the field can gain little useful information from the articles. As a former editor of a scientific journal, I can say that most complaints of this nature come from those who have had little or no recent training at the graduate level. Each decade sees an advance in the degree of specialization in any field of research. A chemist working in one field may have difficulty in-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terpreting the current results of another chemist in a different field of specialization. It can hardly be expected that the details of a basic study on either chemistry or bacteriology can be completely expressed in language so simple that the layman can understand the methods used, and the results obtained, as well as can the experts in these fields. A person who does not understand the symbols used in expressing values, or who has had no advanced training in mathematics or statistical methods, cannot be expected to follow certain scientific articles published in the *Journal of Dairy Science*. It would be ridiculous to expect a well-trained scientist to even attempt to express his methods, results, and conclusions in such language that a college freshman could follow the article as well as he does the sports page in the metropolitan newspaper.

Research in the field of dairying has advanced beyond the trial-and-error and commercial-testing era of so-called research commonly practiced thirty-five years ago. We need make no apology for the research work being done by our leading investigators today. For the most part, these men are not dairy scientists in the same sense as were the founders of our Association. Some of our present dairy experts may never have lived on a farm or milked a cow or worked in a commercial dairy. They are trained in such fields as biochemistry, physiology, protein chemistry, carbohydrate chemistry, fat chemistry, and physics, and have chosen to apply their skills to some field in the dairy industry. What will happen if we tell these men to present their research results in a language so simple that the postman will find the Journal interesting reading? The answer is obvious—they will publish their articles in some other journal that maintains a high editorial standard.

The purpose of a scientific journal is to serve as a vehicle for the exchange of the results of scientific research. Such a publication is not for light reading; neither is it intended to serve the needs of the pseudo scientist or the layman. The many trade journals in every field can be used for this purpose. It should be the duty of investigators in an applied field such as ours to see to it that their completed results are briefed and supplied to interested groups in a form they can comprehend. However, this is not the responsibility of a scientific journal of high order such as the *Journal of Dairy Science*.

The argument has been advanced that if the results of scientific research were written in the layman's language more members and subscribers could be secured and advertising would be easier to obtain. This probably is true, but if this plan were followed, in a short time there would be few articles to publish, because the Journal would no longer be considered a scientific publication by research workers. The main purpose of the *Journal of Dairy Science* is not to serve as a means for the Association to make money; it is to serve as a means of affording contemporary scientists all over the world an opportunity to obtain information they can use in their own dairy teaching and research programs. The Journal is also intended as a guide for future workers in scientific fields.

The additions made to the Journal since 1952, such as the People and Events column, the Guest Editorial column, the Student Chapter News, the Our Industry Today section, and the boxed résumé preceding each scientific article were planned for the interest and information of all readers. It was the thought of the editor, the Journal Management Committee, and the members of the Editorial Board that these additions, if kept within reason, could be made without lowering the dignity of the Journal. However, it was the consensus of these groups that it would be a serious mistake to popularize the scientific articles, which are the backbone of the Journal and its reason for being. At least before a change in editorial policy is made, the membership should be polled as to their wishes.

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OUR ASSOCIATION

Contributions of A.D.S.A. Add Up

DEAR MEMBERS:

It is time for us to visit about the affairs of our Association. As you know, E. O. HERREID, of the Department of Food Technology, Univ. of Illinois, is now Editor-in-Chief of the *Journal of Dairy Science*. This is a tough assignment, but it could be made a lot easier if each of us took time out of our busy lives to send material for publication in "People and Events" and "Our Industry Today." I am sure that Dr. Herreid would also appreciate suggestions for improvement of our Journal.

C. F. Huffman

While attending the Annual Meeting of the Southern Division of A.D.S.A., I visited with J. B. FRYE, Regional Chairman of Membership Drive in his area (7 states). I was surprised to learn that very few people in the dairy industry are familiar with the activities of the A.D.S.A. Dr. Frye suggested that in order to do a good job of attracting members, we need to let people know what we are doing as an organization other than the publication of the *Journal of Dairy Science*.

Our Association has strengthened the relationship with the three divisions of A.D.S.A. I. W. RUPEL, a member of the Executive Board from Texas, represented us at the Western Division Annual Meeting. As you no doubt observed, abstracts of the scientific papers presented at this meeting appeared in the November issue of the Journal. Our congenial secretary, H. F. JUDKINS, represented us at the meeting of the Eastern Division. It was my good fortune to attend the meeting of the Southern Division held in Birmingham, Alabama, February 3-6. The papers presented were of splendid quality. Abstracts of these papers will appear in the Journal.

H. C. OLSON, immediate past Chairman of the Southern Division, is present Chairman of the Divisions Committee of A.D.S.A. This committee has the responsibility of suggesting ways and means of bringing the Divisions closer to the parent organization.

A part of the time of the business meeting of the Southern Division was devoted to a discussion of how to make A.D.S.A. stronger. A motion was passed to have a booth at the next meeting of the Southern Division for obtaining A.D.S.A. membership. The suggestion was also made to have an American Dairy Science Association representative present at all meetings to explain the advantages of membership in our Association. There are numerous dairy meetings where most of those in attendance are potential members of our Association. This is a suggestion that should be adopted nationwide. It would not only increase our membership, but would also increase our prestige.

We are represented on the Dairywide Nutrition Research Committee made up of representatives of 14 dairy organizations. The Committee Chairman this year is Secretary Judkins. The job of this committee is to suggest projects needed to give information on dietary needs of people of all ages, and projects that will give needed information on the nutritive value of milk and milk products. The committee works closely with the National Dairy Council and the American Dairy Association. The A.D.A. is doing a splendid job in making the consumers dairy-products conscious through nation-wide advertising.

Our Education Committee is taking a look at dairy education to make sure that dairy students, upon graduation, will fit into our ever changing Dairy Industry. H. B. HENDERSON of Georgia is our representative on the Sub-Committee on Education of the Dairy Industry Committee.

A recent study revealed that only relatively few dairy manufacturing graduates are being inducted into the Dairy Industry through an organized training program. Many of the dairy industry who do have a training program consider it inadequate to get the job done. The Personnel Manual Preparation Committee of A.D.S.A. is preparing a training manual which may be adopted by any dairy plant operator in training new production employees.

Since the dairy cow is geared by nature with a roughage fermentation vat, it seems logical for us to have representation on the Joint Committee on Grassland Farming. This organization stimulates greater use of good pastures, silage and hay by sponsoring Symposia on Grassland Farming.

Our Association has an Antibiotic Committee that is working with other organizations interested in the control of the use of antibiotics in the treatment of mastitis.

We are proud of the progress of our Student Affiliate Committee. The student affiliate membership is at an all time high. There are now 37 active Student Affiliate Chapters. Some of the objectives of this committee are, (1) to aid in the development of strong affiliate chapters for the purpose of developing the leadership ability of students majoring in dairying, (2) to develop closer relationships between students, faculty, and industry and between

educational institutions, (3) to acquaint students with the American Dairy Science Association, its scope, purposes, and the role of affiliate members in the over-all program.

Dairy students who are familiar with the opportunities in the dairy field make the best recruiters for college training. This training is needed to supply leadership and manpower needs of our industry.

The Public Health Research Liaison Committee was organized to cooperate with the United States Public Health Service with reference to research needs pertaining to milk and milk products.

In addition to the work of all of the committees of the parent organization, mention should be made of the work of the committees in the Manufacturing, Production, and Extension Sections. The Manufacturing Section has working committees on (1) Butter, (2) Curd Tension of Milk, (3) Dairy Judging, (4) Nomenclature and Methodology of Milk Proteins, and (5) Score Card for Cottage Cheese. The joint working committees of the Production and Extension Sections include the following committees: (1) Breed Relations, (2) Dairy Cattle Breeding, (3) Dairy Cattle Health and (4) Type. The Extension Section has committees in (1) Dairy Records, (2) 4-H Club, and (3) Teaching Methods.

The contributions of our Association to the Dairy Industry when added up, are really something of which every member can well be proud. I have been amazed at the large number of our members who are working to keep the Dairy Industry on the march in teaching, research and extension. We should no longer keep our light under a bushel, but should broadcast from the house tops the many accomplishments of our Association. This would go a long way toward increasing the membership of the American Dairy Science Association.

The Membership Committee under the Chairmanship of H. E. CALBERT of the Univ. of Wisconsin, has set our goal at 2200 members. If we all get busy and give the membership drive a shove, we will go over the top.

Stillwater Meeting

Meeting Plans. Plans are well under way for the Annual Meeting in Oklahoma, Thursday, Friday and Saturday, June 27, 28 and 29. The Past Presidents' Dinner will be held Wednesday, June 26. The Recognition Program will be held Saturday evening, June 29. This is our first visit to the Southwest. You should make plans to attend the meeting and help the state of Oklahoma celebrate its Golden Jubilee.

Nomination and Election

Nomination and Election Time. Later on you will receive election material from Secretary Judkins. Candidates for Vice-President and two Executive Board Members will soon be nominated by the Nominating Committee. According to the constitution, the Nominating Committee shall have five members which include the immediate Past-President, one representative each from the Extension, Manufacturing and Production Sections, and one representative of commercial interests. The names of the committee appeared in the January issue of the Journal to permit members to offer suggestions. Such suggestions should be in the hands of the committee not later than April 1.

Yours for a bigger and better Association,

C. F. Huffman

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FROM THE SECRETARY'S DESK

Classification of Duties of Dairy Department Staffs

In the fall of 1956, the head of each Dairy Department was asked to list each staff member and to state whether each member was engaged in teaching, teaching and researching, research, extension or any other combination, and to state whether engaged in production or manufacturing activity. Fifty-four Dairy Manufacturing and/or Dairy Husbandry Departments have been heard from in the United States and Canada. This is not quite 100% but nearly all did reply.

The reports cover the activities of 648 people and the classification of duties is shown in the following table:

Classification	*Number*	*Per cent*
1. Teaching	131	20.2
2. Teaching and Research	268	41.3
3. Research	96	14.8
4. Extension	136	21.0
5. Extension and Research	4	.6
6. Extension and Teaching	3	.5
7. Teaching, Research and Extension	10	1.5

The distribution between production and manufacturing work is as follows:

Production	— 418 or 64.5%
Manufacturing	— 217 or 33.5%
Not stated	— 13 or 2.0%

These figures in part probably account for larger numbers of papers in the production field that are submitted to the Journal. A study is now being made of new and renewal member interests for the year 1957 and to date we have an appreciably larger number of total members interested in manufacturing than we do in production. This would seem to emphasize two different angles:

1. The importance of getting more members from places other than universities who are engaged in production or general agricultural activities, and

2. The importance of trying to get more contributions to our Journal from members in industry who are engaged in product research and processing. — H. F. JUDKINS.

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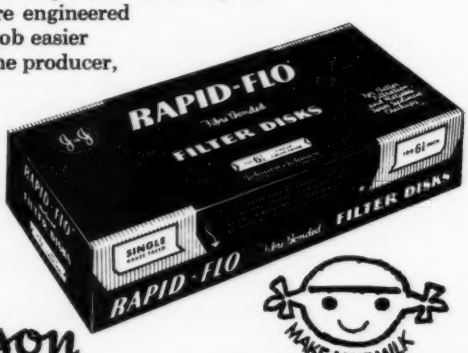

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EFFECT OF STREPTOMYCIN ON GROWTH OF YOUNG CALVES [1]

L. L. RUSOFF, F. T. LANDAGORA, AND BARNEY HARRIS, JR.
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This study, which is a continuation of an earlier one, is an attempt to further clarify the issue as to whether or not streptomycin fed to calves is beneficial. The results indicate that low levels of the antibiotic produce a growth response and a greater feed efficiency. *Editor.*

The value of nutritional levels of streptomycin for monogastric animals has been fairly well established *(1, 3, 4, 5, 11, 12)*. Although this antibiotic has been effective in preventing calf scours *(6, 7, 10)* and ineffective in cellulose digestibility studies *(9)*, its growth-promoting value for young ruminants is doubtful. A few papers have been published on the effects of feeding nutritional levels of streptomycin to young dairy calves. In 1951, Rusoff and Haq *(13)* and Williams and Knodt *(15)* reported that an APF supplement which supposedly contained traces of streptomycin was without effect on dairy calves. Hoque *et al. (8)* in 1954 obtained an 18% increase in growth of dairy calves at 7 weeks of age when 10, 20, or 40 mg. of streptomycin per 100 lb. of body weight was fed. Subsequent antibiotic feeding to 16 weeks of age was without effect. Rusoff *et al. (14)* in 1955 reported preliminary results of feeding streptomycin sulfate (Merck) to calves. A level of 50 mg. of the antibiotic per day increased growth by 13% at 12 weeks of age, whereas a 30-mg. level appeared to have no effect. Recently, Bartley *et al. (2)* reported that 30 or 90 mg. of streptomycin sulfate per 100 lb. of body weight produced a slight growth response in calves only during the first few weeks of age even though the antibiotic was fed up to 16 weeks of age.

This study is a continuation of the preliminary work reported earlier by the authors *(14)*.

EXPERIMENTAL PROCEDURE

Two levels, 50 mg. and 30 mg., of streptomycin daily were investigated.

50 mg. level: 12 male Jersey calves, 3 days of age, from the L.S.U. dairy herd were divided at random into two groups. Group I served as the control and Group II was fed 50 mg. of streptomycin daily to 12 weeks of age. During the milk feeding period, the antibiotic was dissolved in the milk; after weaning, it was fed by capsule. All calves received colostrum for the first 3 days of life, and at 4 days of age they were placed in individual pens. Whole milk was fed at a level of 10% of the body weight for 28 days. A 20% plant protein calf

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[1] This study was supported in part by a grant from Merck and Co. Inc., Rahway, N. J.

starter and alfalfa hay were fed ad lib at 7 days of age. A maximum of 5 lb. of starter was allowed. Similar management procedures for both groups were followed. Records were kept of daily feed consumption and weekly body weight, and the health condition of the calves was observed daily. Leucocyte counts of the blood of each calf were made at 4-week intervals.

30 mg. level: Two groups of four male Jersey and five male Holstein calves each were used. The antibiotic group of this phase received 30 mg. of streptomycin daily. This level was based on the results obtained from the previous trial. The same management and feeding practices as those used in the previous trial were followed. Leucocyte counts of the blood of each calf were also obtained at 4-week intervals.

RESULTS AND DISCUSSION

The average daily gains in weight and the feed efficiency for the two groups of calves used in the first phase are presented in Table 1. The control group of

TABLE 1

Effect of level of streptomycin on gains and feed efficiency

Treatment	Breed	No.	Initial wt. (*lb.*)	Av. daily gain (*lb.*) weeks			TDN/lb. gain
				4	8	12	
Control	Jersey	6	60.7	0.41	0.73	0.84	2.21
Streptomycin (50 mg.)	Jersey	6	59.7	0.37	0.81	0.95	2.19
Control	Jersey	4	54.0	0.23	0.66	0.73	2.52
Streptomycin (30 mg.)	Jersey	4	57.0	0.50	0.55	0.74	2.02
Control	Holstein	5	83.4	0.51	0.84	0.95	2.43
Streptomycin (30 mg.)	Holstein	5	79.6	0.66	0.92	0.92	2.09

calves gained approximately 9% more than the streptomycin group (50 mg. level) at 4 weeks of age. This might be explained by the fact that the antibiotic group had very loose feces, similar to scours, during the first 4 weeks. Thereafter, the calves had very soft feces, but apparently this did not affect their growth response. At 8 and 12 weeks of age the antibiotic-fed calves had gained 10% and 13% more than the controls, respectively. However, these differences were not statistically significant although they approached significance at the 5% level of probability. The antibiotic calves had long, rough haircoats throughout the experimental period. It appears that the 50 mg. level of the antibiotic affected the microflora of the gastro-intestinal tract to cause the loose feces and rough haircoats.

No apparent difference in feed efficiency (TDN/lb. gain) was observed between the two groups (Table 1).

There was a decrease in the leucocyte count of the antibiotic group at 4 weeks of age as compared to the control group (Table 2). This difference was statistically significant at $P < 0.05$.

TABLE 2
Average leucocyte counts of dairy calves per period

Treatment	Breed	No.	Weeks 0–4 (1×10^3)	4–8 (1×10^3)	8–12 (1×10^3)
Control	Jersey	6	5.73	9.72	11.35
Streptomycin (50 mg.)	Jersey	6	7.47	8.55	9.67
Control	Jersey	4	8.66	7.90	8.70
Streptomycin (30 mg.)	Jersey	4	8.06	9.64	8.58
Control	Holstein	5	8.83	11.60	9.06
Streptomycin (30 mg.)	Holstein	5	8.85	9.97	8.58

Since a scour-like condition was observed in the 50-mg. level of streptomycin-fed calves, a lower level (30 mg.) was tried. In this trial, the scour-like condition of the feces was not present in the antibiotic-fed calves, which indicates that the 50-mg. daily level of streptomycin was too high. Bartley *et al. (2)*, however, fed 90 mg. of streptomycin per 100 lb. of body weight to calves without observing any detrimental effects.

It is noted in Table 1 that the 30 mg. level of streptomycin produced a large growth response at 4 weeks of age as compared to the control group even though no scours was observed in any of the calves in the two groups. At 12 weeks of age, no difference in growth gains was observed between the antibiotic-fed and the control groups.

These results are in agreement with the reports of Hoque *et al. (8)* and Bartley *et al. (2)* in that low levels of streptomycin produce a growth response during the early life of a calf. A greater feed efficiency for the antibiotic-fed calves was also observed in this phase (Table 1), as was found by Bartley *et al. (2)*.

There were lower leucocyte counts in the antibiotic-fed (30-mg. level) animals after the fourth week of age as compared with the controls (Table 2). However, these differences were not statistically significant.

SUMMARY

Feeding dairy calves, 30 or 50 mg. of streptomycin sulfate (Merck) daily to 12 weeks of age was investigated. The 30-mg. level stimulated growth only during the first 4 weeks of the animal's life, whereas the 50 mg. level had increased growth by 13% at 12 weeks of age. These values approached significance at the 5% level of probability. The 50-mg. level caused loose feces and rough haircoat.

Leucocyte counts of the animals fed the 50-mg. level of streptomycin were statistically lower than those of the controls ($P < 0.05$) after 4 weeks of age, whereas the counts of those fed the 30-mg. level, although lower than the controls, were not statistically significant.

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A STUDY OF THE VALUE OF CORN DISTILLERS DRIED GRAINS, COCOANUT OIL MEAL, AND CORN GLUTEN FEED FOR MILK PRODUCTION

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Cows receiving corn distillers dried grains produced more milk than did those on either corn gluten feed or cocoanut oil meal. Cocoanut oil meal feeding, however, resulted in milk of a higher fat percentage. *Editor.*

Recent experiments *(11)* have shown that corn gluten feed is not as efficient a protein supplement to a simple concentrate mixture of barley and oats for milk production as are corn distillers dried grains. Cocoanut oil meal is available in some areas, but few recent studies have been carried out in this country to determine the value of the product available on the market.

In 1914, Lindsey *(10)* added a high-fat cocoanut oil meal to a ration of hay and wheat bran for dairy cows and noted a 0.40 percentage unit increase in the fat test as compared with corn gluten feed. Ewing *(4)* compared cottonseed meal with cocoanut oil meal for milking cows and observed an increase of 0.13 percentage units when the cocoanut oil meal was fed. Woll *(19)* reported a greater increase in fat test when he fed 4 lb. of cocoanut oil meal than when only 2 lb. were fed daily. McCandlish and Weaver *(13)* observed an increase of 0.42 percentage units in fat tests of milk when cocoanut oil meal was fed as compared with linseed oil meal. Buschmann *(2)*, Brouwer *(1)*, Kodder *et al. (9)*, and Schmidt *et al. (16)* observed increases in fat tests when cocoanut meal or cake was used in the concentrate mixture for dairy cows. On the other hand, Perkins *et al. (15)* observed no increase in the fat test of milk. Hansen *(7)* has reviewed the earlier literature in Europe and reported that as early as 1864 studies in England showed increases in the fat test of the milk after the feeding of cocoanut oil meal and palm kernel meal. In 1939 Gardner *(6)* observed that adding 20% of a mixture of equal parts of cocoanut oil meal and palm kernel oil meal to a concentrate mixture for milking cows increased the fat percentage of the milk. Henke and Otagoki *(8)* reported that when cocoanut oil meal replaced part of the fish meal and meat and bone meal in a concentrate mixture for dairy cows effecting an increase in the fat content of the concentrate from 3.14 to 4.56%, the fat percentage of the milk increased from 3.42 to 3.7. There was no difference in milk yield on the two feeds.

The studies reported above have not shown any particular advantage in milk production for cocoanut oil meal compared with other protein supplements.

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The cocoanut oil meal on the market at the present time in the United States is somewhat lower in ether extract than the meal of some decades ago. Because of this lowered fat content it appeared worthwhile to reexamine the value of cocoanut oil meal as compared with corn distillers dried grains and corn gluten feed for milking cows.

EXPERIMENTAL PROCEDURE

Two experiments were carried out during 1953-54 and 1954-55. In each study 12 purebred Holstein-Friesan cows, which had recently passed their maximum milk production but had not been rebred, were used. They were fed mixed hay and corn silage plus a concentrate mixture containing approximately 18% of protein during a preliminary period of 4 to 6 weeks to observe levels of production and to adjust feed intakes. The cows were then divided into four replicates on the basis of age and level of production, and each cow was assigned at random to one of the three concentrates to be compared using a 3×3 Latin square design. Each experimental period was 6 weeks in duration. The first week was considered as transition, and the production and feed data obtained during the last five weeks were used in comparing the value of the various feeds.

Concentrate intakes were adjusted at the start of the study to 1 lb. for each 3.5 lb. of fat-corrected milk *(5)* and the allowances were reduced each week in accordance with the average decrease in production of all cows *(12)*. The cows were allowed all of the corn silage they would consume without waste, and good quality mixed hay was fed in excess of the intake to allow 1 to 4 lb. daily orts.

Records were kept of the daily feed intakes and milk production. Composite samples from four consecutive milkings were tested for fat percentage each week. Changes in body weight were determined from an average of weights taken the last three days of both the preliminary period and of each experimental period.

The data were reduced for interpretation by using the analysis of variance technique of Snedecor *(18)*. Differences between treatments were evaluated by the multiple range test of Duncan *(3)*.

RESULTS AND DISCUSSION

The formulae for the concentrate mixtures are shown in Table 1. The federal grade of the hays, as well as the chemical composition and estimated TDN content of all feeds, is shown in Table 2. The method proposed by Schneider *(17)* has been used to estimate the TDN value of the feeds.

The average milk production by the cows on the various feeds during both experiments is shown in Table 3. The average body weights of the cows, the gains in weight, and the feed efficiency are also presented in Table 3. Slightly more milk was produced on the average by cows on corn distillers dried grains during both experiments. The difference was significant ($P < 0.05$) in Experiment II. When the data for the two years were pooled this difference was significant at the 10% level.

TABLE 1
Ingredients used in the concentrate mixtures

Ingredients	Mixture number		
	I	II	III
	(*lb.*)	(*lb.*)	(*lb.*)
Oats, ground	200	200	200
Wheat bran	100	100	100
Corn gluten feed	400	—	—
Corn distillers dried grains[a]	—	400	—
Cocoanut oil meal[b]	—	—	400
Corn meal	187	190	145
Soybean oil meal	43	40	85
Molasses, cane	50	50	50
Iodized salt	10	10	10
Dicalcium phosphate	10	10	10
Total	1000	1000	1000

[a] A blended sample provided through the cooperation of Distillers Feed Research Council, Inc.
[b] Provided by Procter and Gamble, Inc., Cincinnati, Ohio.

Cows receiving the mixture containing the cocoanut oil meal produced milk of a signficantly higher fat percentage than the other two mixtures for both years. When the two experiments were analyzed together, this increase was highly significant ($P < 0.01$). There were no significant differences between rations in the amount of fat-corrected milk produced, indicating that the total

TABLE 2
Chemical composition and TDN content of the feeds

Feed	Moisture	Crude protein	Ether extract	Crude fiber	N.F.E.	Ash	Estimated T.D.N.
	(%)						
Experiment I, 1953-54							
Concentrate mixture containing:							
Corn gluten feed	9.1	17.9	3.0	7.2	57.5	5.3	73.6
Corn distillers dried grains	7.3	18.2	4.4	5.7	60.3	4.1	79.5
Cocoanut oil meal	8.1	18.7	4.2	8.8	54.3	5.9	73.2
Hay[a]	10.5	9.4	1.8	31.6	42.5	4.2	45.6
Corn silage	78.2	1.8	0.3	6.4	12.3	1.0	12.7
Experiment II, 1954-55							
Concentrate mixture containing:							
Corn gluten feed	8.3	18.5	3.2	7.2	55.5	7.3	72.2
Corn distillers dried grains	6.8	18.4	4.8	8.3	55.4	6.3	75.2
Cocoanut oil meal	7.8	17.4	3.5	9.8	54.0	7.5	70.0
Cocoanut oil meal	10.5	17.9	5.5	12.2	47.1	6.8	67.4
Corn distillers dried grains	6.1	23.4	5.7	13.0	49.5	2.3	75.4
Hay[b]	8.2	8.0	2.2	36.4	40.8	4.4	40.9
Corn silage	71.1	2.2	0.6	6.0	19.1	1.0	19.3

[a] U.S. No. 1 extra green mixed hay, consisting of timothy, 57.3%; birdsfoot trefoil, 24.8%; quack grass, 11.7%; red top and blue grass, 6.2%; color, 67%; and foreign material, 4%.
[b] U.S. No. 1 mixed hay, consisting of timothy, 33.0%; birdsfoot trefoil, 25.5%; blue grass and red top, 24.2%; quack grass and rye grass, 15.7%; and alfalfa and clover, 1.6%; color, 58%; and foreign material, 1.1%.

TABLE 3
Average daily milk and fat production, body weights and feed efficiency

Mixture containing	Average daily				Average body weight	TDN/lb. FMC[e]
	Milk	Test	F.C.M.	Weight gain		
	(*lb.*)					
Experiment I, 1953-54						
Corn gluten feed	36.8	3.66	34.8	0.16	1239	0.64
Corn distillers dried grains	37.3	3.64	35.2	0.54	1236	0.65
Cocoanut oil meal	36.9	3.85[a]	36.0	0.36	1239	0.60[b]
Experiment II, 1954-55						
Corn gluten feed	41.1	3.77	39.6	0.08	1293	0.61
Corn distillers dried grains	42.6[c]	3.76	41.0	0.05	1286	0.59[d]
Cocoanut oil meal	40.8	3.93[c]	40.1	0.51	1292	0.59[d]

[a] Significantly greater than the other two mixtures ($P < 0.01$).
[b] Significantly less than the other two mixtures ($P < 0.05$).
[c] Significantly greater than the other two mixtures ($P < 0.05$).
[d] Significantly less than the mixture containing corn gluten feed ($P < 0.05$).
[e] Total pounds of TDN consumed daily divided by the daily pounds of FCM produced.

energy production was essentially the same on all three concentrate mixtures. The practical application of the results is interesting in light of the recent trends in the relative markets for milk and butterfat. The slight superiority of corn distillers dried grains over corn gluten feed confirms earlier research *(11)*.

The utilization of TDN was more efficient for cows on the cocoanut oil meal than for those on the other rations. This improvement was significant ($P < 0.05$) when the two years were considered together. The small differences in body weight and average daily gain were not significant.

SUMMARY

Two lactation experiments were conducted with 12 cows in each test, fed concentrate mixtures containing corn gluten feed, corn distillers dried grains, or cocoanut oil meal at a level of 40% of the mixture. The feed containing cocoanut oil meal resulted in a highly significant increase in the fat content of the milk. Cows receiving corn distillers dried grains produced more total milk ($P < 0.10$)

TABLE 4
Average daily feed intakes

Mixture containing	Concentrate	Hay	Silage
	(*lb.*)	(*lb.*)	(*lb.*)
Experiment I, 1953-54			
Corn gluten feed	11.1	22.7	26.1
Corn distillers dried grains	11.1	22.2	26.5
Cocoanut oil meal	11.1	21.3	26.2
Experiment II, 1954-55			
Corn gluten feed	13.0	20.5	29.0
Corn distillers dried grains	13.1	18.9	28.7
Cocoanut oil meal	12.9	20.6	28.1

than when on the two other mixtures. The differences in production of fat-corrected milk were not significant.

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A STUDY OF THE SHORT-TERM USE OF IODINATED CASEIN FOR MILK PRODUCTION

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The methods of withdrawing thyroprotein from rations and its effect on milk production have been controversial. The authors have shown that gradual, as well as abrupt, withdrawal of thyroprotein did not prevent a rapid decrease in milk production. *Editor.*

It has been amply demonstrated that milk production will usually increase after the administration of thyroactive materials. The subject has been adequately summarized in recent reviews *(4, 5, 12)*. A permanent increase in the level of milk production apparently does not persist throughout the entire lactation period *(1, 6, 8, 10, 13)*. Most of the results have indicated that the feeding of thyroactive materials for the greater portion of the lactation period has not resulted in an increase in the total milk produced for the entire lactation *(1, 6, 8, 9, 13)*.

The use of thyroprotein[3] to increase milk production for short periods of time has received recent attention *(11, 14)*. It has resulted in an economic advantage which was dependent on the degree of response in milk production during thyroprotein feeding and the decrease after thyroprotein feeding. The large decrease in milk production that occurred after the cessation of thyroprotein feeding was a deterrent to the use of the material. Reports as to the effect of gradual withdrawal of thyroprotein are controversial. Some *(3, 11)* indicated that this practice prevented the large decrease in milk production that occurred when it was withdrawn abruptly; while others *(14)* have questioned the validity of such findings.

The data presented in this paper were collected in order to determine if gradual removal of thyroprotein would prevent the large decrease in milk production that has previously been observed to follow the cessation of thyroprotein feeding. It also provided data on the economics of short-time thyroprotein feeding.

EXPERIMENTAL PROCEDURE

Experiment A was performed at Huntley, Montana. during the winter of 1954. Experiment B was performed at Bozeman, Montana, during the same

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[3] A standardized thyroactive iodinated casein marketed under the trade name of Protamone, manufactured by Cerophyll Corp., now Agri-Tech, Inc., Kansas City, Mo.

TABLE 1

Data on cows and design of experiment

Group No.	No. of cows[f] H J	Days in milk[a]	Age[a]	Thyroprotein fed: For 60 days	Next 10 days	Next 10 days	Next 10 days	Next 60 days	Additional grain fed during thyro.
			(mo.)	*(g/cow/day)*					
				Experiment A					
1	4 – 0	103	67	0	0	0	0	0	3
2	4 – 0	98	65	15	6	0	0	0	3
3	4 – 0	97	69	15	10	7-4[b]	0	0	3
4	4 – 0	94	69	15	10	7	4	0	3
				Experiment B					
1	2 – 2	93	61	0	0	0	0	0	3
2	2 – 2	93	51	15	5	0	0	0	3
3	2 – 2	86	57	15	10	0	0	0	3
4	2 – 2	98	52	15	10	7	4	0	3
				Experiment C					
1	4 – 5	120	58	0	0	0	0	0	none
2	1 – 1	116	59	15	6.5	0	0	0	4 or 5
3	6 – 3	135	55	15	8.5	4.3[c]	0	0	4 or 5
4	1 – 1	115	63	15	9.0	5.0	2.5	0	4 or 5
5	3 – 6	148	64	15	0	0	0	0	4 or 5
6	6 – 3[d]	85	67	15	0[e]	0	0	0	4 or 5[d]
Period				Treatment		Withdrawal		Post-treatment	

[a] At beginning of pretreatment period.
[b] Ten g. for first week; 7 for the second and 4 for the next 6 days.
[c] These cows placed on good pasture, immediately after thyroprotein was withdrawn; hay was also offered some of these cows.
[d] Six cows at Beltsville, 3 cows at Huntley; the latter received only 3 lb. extra grain.
[e] Some cows same as for footnote[b].
[f] H = Holstein, J = Jerseys; grain usually fed at 1:4 for Holsteins and 1:3 for Jerseys.

winter. Experiment C was performed at Beltsville, Maryland, and at Huntley, Montana, from 1952 to 1955. Data on the groups of cows used and the amounts and length of time that thyroprotein was fed are shown in Table 1.

The experimental period was divided into a 30-day pretreatment period, a 60-day treatment period, a 30-day withdrawal period, and a 60-day post-treatment period. During the withdrawal period thyroprotein was gradually removed in 10, 20, or 30 days from the cows in groups 2, 3, and 4, respectively. It was removed abruptly from cows in groups 5 and 6, and the latter were then placed on good pasture. Data on milk production and fat test during the 30-day period before the experiment commenced are shown in the figures to help show trends. In experiments A and B it was planned that the three groups of cows that received thyroprotein for 60 days would have thyroprotein withdrawn over the next 10, 20, or 30 days. However, a typographical error occurred in the instructions to the herdsman and consequently thyroprotein was withdrawn over a 10-day period in group 3 of experiment B instead of the intended 20-day period.

In experiments A and B, replicates of four cows each were chosen (with restriction as to breed in experiment B) so as to be approximately equal in level

of milk production and stage of lactation, and then randomly assigned to treatment groups. In experiment C the cows were placed in one of the treatment groups as they became available. Cows in their second to seventh lactation were used. Most of the cows started on thyroprotein during the mid-portion of the lactation period (Table 1). Thyroprotein was fed to the cows during the fall, winter, or early spring months only. All cows in group 6 were treated during the early spring of 1954 so that good pasture was available after the treatment period ended.

Extra grain was fed to all cows during the time that thyroprotein was fed. Three pounds extra were fed to the cows in experiments A and B, and to the cows in group 6 at Huntley. Four or five pounds extra were fed to the treated cows in experiment C when thyroprotein was fed and for an additional 10 days. In experiment C the control group (group 1) received extra grain throughout all the period of observation and the pretreatment period (Table 1). The general details of the experiment were the same as in a previous trial *(14)*.

In calculations for efficiency and economy of milk production the data for the 60-day treatment period were combined with the data for the withdrawal and post-treatment period. Reasons for this have been discussed previously *(14)*.

RESULTS AND DISCUSSION

Milk production increased in 52 of the 55 cows that received thyroprotein. The average increase was 6.3 and 5.8 lb. of fat-corrected milk (FCM) per cow per day for the first and second months, respectively, of thyroprotein feeding when calculated according to the method used by Bailey *et al. (2)*. By the same calculation procedure the increase amounted to 16.5 and 15.1%, respectively.

Not all cows responded to thyroprotein feeding to the same extent. Neither did the groups respond to the same extent. This is seen in the data presented in Figures 1 and 2 where the trends in FCM production are shown. Large variation between the groups is also seen in the summary data on milk production presented in Table 2.

The average change in FCM production between the pretreatment and the treatment periods for all groups of each experiment is given in Part I of Table 2. When the groups are considered separately, there was an increase in the production from the pretreatment to the treatment period for all groups of all experiments except for group 3 of experiment B. The difference between the treated cows and their respective control group was significant ($P < 0.01$ or $P < 0.05$) in 8 of the 11 groups. When the treated groups of each experiment were combined, the net differences between the treated groups and their respective control group were 7.9, 5.6, and 5.8 lb. FCM per cow per day for experiments A, B and C, respectively. These differences are indicated in Part I of Table 2. Similar differences (9.1 and 7.8) in the previous experiment *(14)* were all significant ($P < 0.01$).

The amount of milk produced by the different groups during the treatment period was compared and is presented in Part II of Table 2. The average values

TABLE 2

Data on milk production, fat tests and body weight of the experimental groups

Items compared	Experiment	Group number 1	2	3	4	5	6	All treated groups
Part I								
Change in FCM production between pretreatment and treatment period (average pounds/cow/day)	A	− 2.8	+ 7.3**	+ 3.8*	+ 4.2*	——	——	+ 5.1**
	B	− 2.9	+ 8.2**	− 1.7	+ 1.7	——	——	+ 2.7
	C	− 2.6	+ 1.6	+ 1.5**	+ 8.2**	+ 3.4**	+ 3.7**	+ 3.2**
		− 2.7 ± 2.8[b]						+ 3.5** ± 4.6
Part II								
FCM produced during treatment period (pounds/cow/day)	A	44.5	53.3**	46.3	50.2*	——	——	50.0
	B	38.6	51.4*	38.7	42.3	——	——	44.2
	C	31.4	34.0	35.7	38.5	32.6	42.9*	36.9
		36.2 ±10.6						41.4[a] ±11.4
Part III								
FCM produced during first 30 days post-treatment (pounds/cow/day)	A	37.3	30.7*	23.5**	28.0**	——	——	27.4*
	B	33.1	28.7	23.2*	26.4	——	——	26.1
	C	23.8	13.6	17.2	16.5	14.8	22.7	17.8
		28.6 ±11.7						21.7** ± 8.7
Part IV								
Difference between calculated expected and observed FCM production during first 30 days of post-treatment period (pounds/cow/day)	A	+ 2.0	− 3.7	− 8.3*	− 6.4	——	——	− 6.1*
	B	+ 2.1	− 3.7	− 7.0*	− 4.0	——	——	− 4.9*
	C	− 1.7	−10.6**	− 8.3*	− 6.2*	− 7.0*	− 6.9*	− 7.5**
		− 0.5 ± 4.2						− 6.8** ± 5.7
Part V								
Regression coefficient for FCM production during 81st to 150th day (pounds/cow/day)	A	− 0.9	− 3.1**	− 2.9**	− 3.2**	——	——	− 3.1**
	B	− 0.6	− 2.9*	− 2.1	− 1.8	——	——	− 2.3*
	C	− 1.4	− 2.9*	− 2.6*	− 3.6**	− 2.7*	− 2.4	− 2.8**
Part VI								
Change in butterfat test from pretreatment to next 70 days	A	− 0.2	+ 0.2*	− 0.0	− 0.0	——	——	+ 0.1
	B	− 0.2	− 0.4	− 0.5	− 0.1	——	——	− 0.3
	C	+ 0.1	+ 0.5	+ 0.2	+ 0.5	+ 0.4*	+ 0.2	+ 0.3
		− 0.0						+ 0.1
Part VII								
Change in body weight during first 30 days of treatment period (pounds/cow/day)	A	+ 0.9	− 2.0**	− 1.5**	− 2.1**	——	——	− 1.9**
	B	+ 0.4	− 2.7**	− 2.8**	− 2.8**	——	——	− 2.8**
	C	+ 0.5	+ 0.3	− 1.5**	+ 0.5	− 0.7*	− 1.2**	− 0.9**
Part VIII								
Regression coefficient for body weight from 90th to 130th day (pounds/cow/day)	A	+ 0.4	+ 2.7*	+ 2.6*	+ 2.4*	——	——	+ 2.6**
	B	− 0.4	+ 1.5	+ 2.1	+ 1.5	——	——	+ 1.7*
	C	+ 0.5	+ 2.7	+ 2.4	+ 3.3*	+ 1.2	+ 2.4	+ 2.4**

[a] Higher than control cows; P = 0.10.
[b] Average with standard deviation.
* Different from control cows; P < 0.05.
** Different from control cows; P < 0.01.

for the treated groups during the pretreatment period were very similar to those of the control groups. This can be seen in some of the data given in Table 3, where it is indicated that there was no statistical difference in level of milk production between control and treated groups during the pretreatment period. However, during the treatment period, all treated groups produced more milk than did their respective control groups. The difference was statistically significant in only 4 of the 11 treated groups (Part II, Table 2). The 55 treated cows averaged 5.16 more pounds of FCM per cow per day than did the 17 control cows during the treatment period (significance of this difference $P = 0.10$); whereas, during the pretreatment period they averaged 0.97 lb. less.

In both experiments A and B, group 2 produced more milk than did group 3 ($P < 0.05$), yet during this time these groups received the same treatment and were at a similar stage and level of production when treatment was started. This is a demonstration of the variability in response that can be expected when a small number of cows are fed thyroprotein.

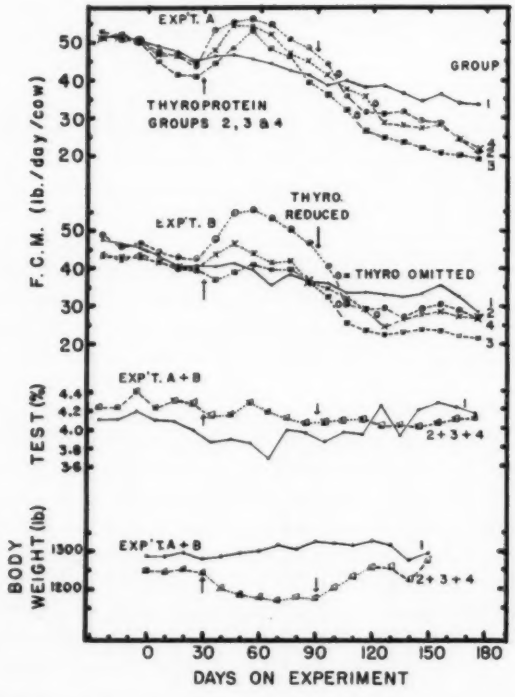

FIG. 1. Trends in the FCM production of the control group of cows and three groups of cows in experiment A and B that were fed thyroprotein for 60 days followed by a gradual removal over the next 10, 20, or 30 days. All treated groups were combined for presenting trends in butterfat tests and body weights.

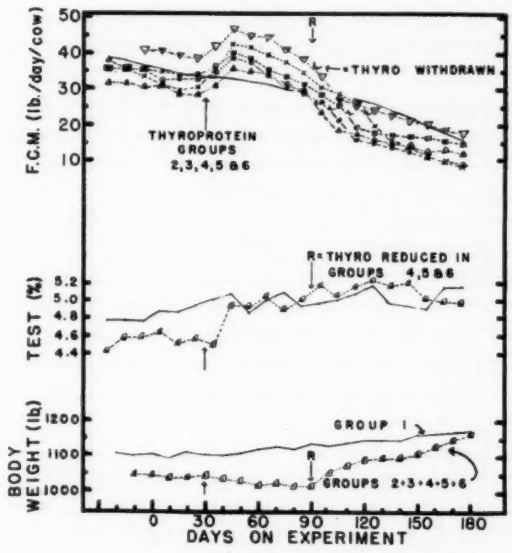

FIG. 2. Trends in the FCM production of the control cows and five groups of cows in experiment C that were fed thyroprotein for 60 days followed by different procedures for its withdrawal. Average trends in butterfat test and body weight are shown for the control and treated cows combined. See text and Table 1 for further details.

Group 1 = solid line; group 2 = equilateral triangle with dot; group 3 = equilateral inverted triangle with dot; group 4 = circle with dot; group 5 = square with dot; and 6 = x, and treated groups combined = right-angled triangle with dot.

The data shown in Figures 1 and 2 indicate that the gradual removal of thyroprotein delayed the abrupt decrease in milk production but did not influence the level to which the production eventually declined in the post-treatment period. The level of milk production during the first 30 days of the post-treatment period is presented in Part III of Table 2. The production level of all the treated groups was below that of their respective control groups during this time. Individual group influences were not always significant. However, when all groups were combined the 17 control cows produced more milk during this time than did the 55 cows that had received thyroprotein ($P < 0.01$). A similar observation was noted in a previous experiment *(14)*.

As another means of demonstrating the marked decrease in production which occurs when thyroprotein feeding is discontinued, the expected FCM production of all cows during the first 30 days of the post-treatment period was calculated. This was done by assuming a 7% decrease per month from the level during the pretreatment period. The differences between the calculated expected yield and the observed yield during the first post-treatment month are compared and presented in Part IV of Table 2. Every treated group had a greater decrease from expected level than their respective control group in this comparison. The differ-

ence for each of the individual treated groups was not always significant. However, the difference between all the control and treated cows was significant ($P < 0.01$).

The regression coefficients for FCM production during the time of withdrawal likewise indicated that milk production dropped rapidly when thyroprotein was withdrawn and that method of withdrawal had little effect on the drop in production. Regression coefficients were calculated for the FCM yields from the 91st to the 140th experimental day and also from the 81st to the 150th day. Both values gave the same results. The latter are presented in Part V of Table 2. The regression coefficients were larger for each of the treated groups than for any of the control groups. This difference was significant in 8 of the 11 groups and also significant when the treatment groups as a unit were compared with the control cows. In all three experiments there were no significant differences in the regression coefficients among the groups having different rates of thyroprotein removal during this time.

All the above comparisons therefore indicate that, although the longer periods for withdrawal of thyroprotein brought about a more gradual decrease in FCM production than the more rapid rates (Figures 1 and 2), there were no significant differences in the production during and after the withdrawal period.

In a previous experiment *(14)* some cows were placed on pasture 5 days after the abrupt removal of thyroprotein from the ration and did not decrease in milk production. The cows in group 6, experiment C, decreased to a lesser extent when placed on pasture after thyroprotein feeding ceased than any of the other groups. Their regression for milk production (Part V, Table 2) was one of the lowest of all the treated groups in this experiment. This method appears to be the method of choice, provided one can follow it when thyroprotein has to be withdrawn from the ration of the milking cow. The results of the experiment do not confirm the claims made by other investigators in regard to the gradual removal of thyroprotein *(3, 11)*. Reasons for the difference are not apparent.

In order to determine if the treated cows produced more milk during and after the treatment period, the milk produced during this time has been calculated. It has been compared to that of the controls during this time and during the pre-experimental period and is shown in Table 3. In experiments A, B, and C the cows that received thyroprotein actually produced slightly less milk than did the control cows. The differences were -0.3, -1.0, and -0.5 lb. per cow per day in experiments A, B, and C, respectively. None of these differences were statistically significant nor were these differences significant in a previous experiment *(14)*. The more gradual rates of thyroprotein withdrawal did not increase the total milk produced over the experimental period when compared to abrupt removal.

These data show that feeding thyroprotein under the conditions of this experiment did not increase total production for the entire period considered. Since the end of the experimental period was close to the end of lactation for these

TABLE 3

Average FCM produced during pretreatment period compared to that produced during treatment plus withdrawal plus post-treatment periods

Days	Group number 1	2	3	4	5	6	All treated cows	Treated-control difference
				(Average lb/day/cow)				
				Experiment A				
0-30	47.3	46.0	42.6	46.0	—	—	44.8	2.4
31-180	40.0	39.9	33.6	38.3	—	—	37.3	2.7
Change	− 7.3	− 6.1	− 9.0	− 7.7	—	—	− 7.6	−0.3
				Experiment B				
0-30	41.5	43.3	40.4	40.6	—	—	41.4	0.1
31-180	35.4	38.8	30.0	34.1	—	—	34.3	1.1
Change	− 6.1	− 4.5	−10.4	− 6.5	—	—	− 7.1	−1.0
				Experiment C				
0-30	34.0	32.3	34.2	30.3	29.2	39.6	33.9	0.1
31-150	28.7	25.7	28.2	30.4	24.9	34.3	29.0	0.3
Average Change	− 5.3	− 6.6	− 6.0	+ 0.1	− 4.3	− 5.3	− 4.9	+0.4
31-180	26.6	22.5	25.7	26.2	24.1[a]	31.3	26.6	0.0
Average Change	− 7.4	− 9.8	− 8.5	− 4.1	− 7.4	− 8.3	− 8.0	−0.5

[a] Value is average of five cows; four others were dried off during the last month.

cows, it is safe to assume that no increased production for the entire lactation was obtained by feeding thyroprotein. Similar observations have been made by other investigators *(1, 6, 8, 13)*.

Effect on fat test. The average trends in butterfat test are shown in the middle portion of Figures 1 and 2. The change in fat test from pretreatment level to time when thyroprotein was effective is given in Part VI of Table 2. In experiments A and B only nine of the 24 cows that received thyroprotein showed an increase in fat test; whereas, in experiment C, 29 of the 31 cows showed some increase in fat test. In only two of the 11 experimental groups was the fat test change significant, and the average change for all treated cows was not significantly different from the average for all the control cows (Table 2). In a previous experiment *(14)* this change was significant ($P < 0.01$). Reasons why some cows increase their fat test and other cows do not change fat test when thyroprotein feeding commences is not evident.

Effect on body weight. The average trends in body weight are shown in the lower portion of Figures 1 and 2. The major change was the large decrease that occurred in the treated cows during the first 30 days of the treatment period. Only small changes occurred during the second 30 days of the treatment period. The changes in body weight during the first 30 days of the treatment period and their statistical significances are shown in Part VII of Table 2. The decrease for most individual groups and the average for all treated animals as a unit was significant ($P < 0.01$) when compared to the control cows.

The weight loss for the cows in experiment C was much less than for the cows in experiments A and B. This may be accounted for by the fact that the cows in experiment C, at Beltsville, were fed more extra grain during the treat-

ment period than were the cows at the other locations in experiments A and B. Three cows in group 6 were at Huntley and received only three extra pounds of grain. Their body weights have been excluded from the averages given for group 6 since they lost 2.2 lb. per cow per day; whereas, the other cows in group 6 fed more extra grain lost only 1.17 lb. per cow per day.

All cows gained in body weight when thyroprotein was removed from the ration. The gradual removal of thyroprotein caused a gradual increase in body weight during the time of its removal. Cows with the longest period of removal had the more gradual weight increases. The differences in the regression coefficients for body weight gain as affected by rate of removal of thyroprotein, however, were not statistically significant. The body weight gain for the treated cow, however, was distinctly greater than that of the control cows during this time ($P < 0.05$ or $P < 0.01$, Part VIII, Table 2). Only three cows out of the 55 that received thyroprotein failed to attain their pretreatment body weight by the 130th day of the experiment.

These data indicate that weight losses can be reduced or minimized after thyroprotein feeding to older cows in mid-lactation, provided that a sufficient amount of extra grain is also fed. The feeding of thyroprotein for 60 to 90 days had practically no effect on the body weights of cows 2 months after treatment ceased. The weight losses under these conditions appear to be of no practical consequence since all this weight loss was gained back soon after the cessation of thyroprotein feeding.

Effect on efficiency of production. Since milk yield during and after thyroprotein feeding was influenced by the treatment, it is only logical that all this period of influence should be considered when making estimate of the efficiency and monetary effects ascribable to thyroprotein feeding. In these calculations the efficiency of each group during the pretreatment period was compared to its efficiency during the remainder of the experimental period including the post-treatment period. The average amount of FCM produced per pound of total digestible nutrients (TDN) consumed is thus compared in Table 4. This term is usually a measure of gross efficiency. The first two columns of data in Table 4 were obtained without considering body weight changes and the second two columns were obtained by correcting for body weight changes by assigning the usual TDN values to body weight changes *(7)* for the entire period.

In experiments A and B the efficiency was approximately the same when calculated by both methods since the net body weight change from the beginning to the end of the comparison periods was very small. In experiment C, the efficiency was larger when the changes in body weight were considered because of greater weight increases in experiment C than in either A or B. Gross efficiency decreases as the lactation period progresses, and this change was comparable in both control and treated cows of experiments A and B (Table 4). However, in experiment C the over-all decrease as lactation progressed was greater for all the treated groups of cows than it was for the control cows. In this experiment the gross efficiency for the treatment, withdrawal and post-treatment periods com-

TABLE 4

Efficiency of milk production as influenced by thyroprotein feeding

Days	FCM per pound TDN		FCM per pound TDN corrected for body weight changes	
	Group Number		Group Number	
	1	2+3+4+5	1	2+3+4+5
		Experiment A		
	Pretreatment period			
1-30	1.76	1.69	1.81	1.70
	Treatment plus withdrawal plus 30 days of post-treatment periods combined			
31-150	1.48	1.43	1.51	1.49
Decrease	0.28	0.26	0.30	0.21
		Experiment B		
	Pretreatment period			
1-30	1.85	1.97	1.71	1.92
	Treatment plus withdrawal plus 10 days of post-treatment periods combined			
31-130	1.52	1.65	1.63	1.64
Decrease	0.33	0.32	0.08	0.28
		Experiment C		
	Pretreatment period			
−30− +30	1.67	1.77	1.71	1.83
	Treatment plus withdrawal plus 30 days of post-treatment periods combined			
31-150	1.49	1.37	1.63	1.58
Decrease	0.18	0.40**	0.08	0.25

** Different from group 1 ($P > 0.01$).

bined was lower for the cows that received thyroprotein than it was for the control cows. The difference in decrease from pre-experimental period was significant between the control and treated groups ($P < 0.01$).

The gross efficiency increased during the time when thyroprotein was actually fed (treatment period) and then decreased after it was withdrawn (post-treatment period). These data indicate that when the entire experimental period was considered, the feeding of thyroprotein under the conditions of these experiments did not increase the efficiency for milk production, and that it actually decreased it in one of the three experiments. The efficiency was comparable to that of control cows in the other two experiments.

Economic considerations. The monetary returns above feed costs were calculated from the average milk yields and the feeds fed. These amounts and the prices used are indicated in Table 5. In all experiments the return above feed costs decreased as lactation progressed.

In experment A during the pretreatment period the cows in groups 2, 3, and 4 returned 13¢ per cow per day less than the cows in group 1. During the treatment plus the withdrawal plus the post-treatment periods combined they returned 9¢ less. In this comparison the cows that received thyroprotein were comparatively more profitable than the control cows. In experiment B during the pretreatment period the cows in groups 2, 3, and 4 returned 5¢ more per cow per day than did the cows in group 1. During the treatment plus the withdrawal plus the post-treatment periods they returned 1¢ per cow per day less than did

TABLE 5 (Continued)

Average production, feed consumption, body weight changes, and monetary returns above feed costs of control and thyroprotein-fed cows

Group No.	Milk	Average test	Feeds fed					Body weight change	Net return above feed cost[a]	Difference
			Alfalfa	Grain	C. S.	Alfalfa silage D. M.	Thyroprotein			
	(lb/day/cow)		*(lb/day/cow)*				*(g/day/cow)*	*(lb/day/cow)*	*($/day/cow)*	
					Experiment A					
	30-day pretreatment period									
1	49.96	3.64	37.9	12.6	0	0	0	+0.21	1.37	—
2	48.32	3.68	37.0	12.6	0	0	0	+0.07	1.30	—
3	44.77	3.67	39.2	11.7	0	0	0	−0.02	1.10	—
4	47.72	3.76	36.5	12.5	0	0	0	+0.08	1.32	—
									1.24	−0.13
	60-day treatment plus 30-day withdrawal plus 30-day post-treatment period									
1	44.47	3.53	39.7	12.1	0	0	0	+0.18	1.01	—
2	44.58	3.86	40.6	13.1	0	0	8.0	+0.54	1.06	—
3	39.05	3.65	40.8	11.6	0	0	8.7	+0.35	0.72	—
4	43.60	3.71	37.6	12.9	0	0	9.3	+0.06	0.98	—
									0.92	−0.09
					Experiment B					
	30-day pretreatment period									
1	39.81	4.34	30.4	12.0	0	0	0	−0.68	1.19	—
2	40.21	4.51	29.0	12.1	0	0	0	−0.01	1.32	—
3	37.41	4.53	27.9	12.0	0	0	0	+0.09	1.19	—
4	39.14	4.23	26.7	11.0	0	0	0	−0.47	1.20	—
									1.24	+0.05
	60-day treatment plus 30-day withdrawal plus 30-day post-treatment period (20 of which was on pasture)									
1	35.36	4.17	28.4	11.1	0	0	0	+0.04	0.96	—
2	39.59	4.26	27.9	12.4	0	0	7.9	−0.18	1.14	—
3	30.87	4.22	24.8	10.2	0	0	8.3	+0.08	0.78	—
4	34.79	4.17	25.0	11.3	0	0	9.3	−0.18	0.93	—
									0.95	−0.01

TABLE 5 (Concluded)

Average production, feed consumption, body weight changes, and monetary returns above feed costs of control and thyroprotein-fed cows

Group No.	Milk	Average test	Feeds fed					Body weight change	Net return above feed cost[a]	Difference
			Alfalfa	Grain	C. S.	Alfalfa silage D. M.	Thyroprotein			
	(lb/day/cow)		*(lb/day/cow)*				*(g/day/cow)*	*(lb/day/cow)*	*($/day/cow)*	
					Experiment C					
	60-day pretreatment period									
1	33.45	4.46	11.2	17.9	16.3	0	0	+0.13	0.92	—
2	34.19	4.18	13.3	10.2	24.0	0	0	−0.17	1.08	—
3	33.19	4.37	5.3	10.1	37.6	6.1	0	+0.05	1.00	—
4	32.08	4.35	10.0	9.8	23.6	4.2	0	−0.12	0.99	—
5	27.65	4.59	13.1	8.6	29.9	9.0	0	+0.36	0.63	—
									0.92	+0.00
	60-day treatment plus withdrawal plus 30-day post-treatment periods combined									
1	26.36	4.58	11.6	14.2	16.0	0	0	+0.47	0.69	—
2	22.23	5.03	9.4	11.3	33.3	0	8.0	+1.05	0.53	—
3	25.71	4.65	7.7	11.4	46.2	0	8.6	+0.54	0.57	—
4	27.37	4.74	10.9	13.4	32.3	0	8.9	+0.99	0.67	—
5	21.44	5.19	9.4	9.4	42.0	9.0	7.5	+0.78	0.29	—
									0.51	−0.18

[a] Corrected for changes in body weight during period considered by assuming 1 lb. body weight loss = 2.73 lb. TDN; 1 lb. body weight gain = 3.53 lb. TDN and 1 lb. TDN = 0.3 lb. FCM and usual correction factors for converting FCM to milk of that actual fat test. Prices used were: milk, $5.60/cwt. for 4% milk with an $.08 differential per 0.1% in fat test; alfalfa, $42.00/ton; grain, $80.00/ton; thyroprotein containing concentrate, $7.00/cwt., or $0.06 gram Protamone; pasture, $5.00/cow/month.

the control cows. In this comparison the cows that received thyroprotein lost 6¢ per cow per day when compared to the control cows. In this latter calculation a blanket cost of pasture for the last 20 days was used. However, the same trend was present when calculations were made that omitted all data on the 20-day pasture period.

In experiment C during the 60 days before treatment the cows in group 1 and those in groups, 2, 3, 4, and 5 combined had the same returns above feed costs. However, during the treatment plus withdrawal plus 30 days of the post-treatment periods combined, the treated cows returned 18¢ per cow per day less than did the control cows. In experiment C when a longer post-experimental period was used, the cows that received thyroprotein showed a still larger comparative decrease in monetary returns (19¢). This undoubtedly would also have been true in experiments A and B if a longer post-experimental period had been considered, since their production in the post-treatment period remained below that of the control cows. In all the above comparisons a similar difference was found when body weight changes were not considered in the calculations.

The above comparisons were made on average values for all the treated groups. There was a difference in monetary returns due to thyroprotein feeding among experiments A, B, and C and a large difference among the groups of each experiment. The cows in groups 2 and 4 of experiment A and of group 2 in experiment B showed the greatest increase in monetary returns over comparable control cows. These are the same groups that showed a significant difference in milk produced during the treatment period (Part II, Table 2). It is evident that the amount of response determines the extent of the change in monetary returns. The extra amount of grain that was fed to the animals in experiment C helped alleviate the large weight losses, but certainly it did not help the monetary returns. The removal of thyroprotein over a 20- or 30-day period did not appreciably influence monetary returns nor gross efficiency as compared to a 0- or 10-day period of removal.

SUMMARY

Three experiments at different locations were performed in which a total of 55 cows, divided into five groups, were fed thyroprotein while 17 cows served as controls. Data on milk production, fat test, body weight, efficiency of production, and monetary returns were obtained.

During the first 60 days of thyroprotein feeding there was a comparative increase of 6.0 lb. FCM, or an increase of 15% in FCM production, but no change in fat test. The increased production was significant in only 8 of the 11 groups that received thyroprotein. By combining all treatment and control groups the increase was significant ($P < 0.01$). At the end of the 60-day period thyroprotein was gradually withdrawn over the next 0, 10, 20, or 30 days. The longer period of thyroprotein withdrawal caused a more gradual decrease in milk production, but the differences were not significant. The production during the period after the complete removal of thyroprotein of all treated groups decreased to and remained below calculated expected yields and also below the actual production

of control cows. The different methods of thyroprotein removal in this experiment caused no significant difference in *(a)* total milk produced after the withdrawal, *(b)* variations between observed and expected yield during this time, and *(c)* regression coefficient for production or body weight during the time of withdrawal. In fact, the over-all responses to gradual withdrawal were not significantly different from those observed when thyroprotein feeding ceased abruptly. The gradual withdrawal of thyroprotein in these experiments did not prevent the large, rapid, and precipitous drop in milk production that occurs after the removal of thyroprotein from the ration.

The feed efficiency for milk production and its change as lactation progressed was similar in control and thyroprotein-fed groups when the period during and after thyroprotein feeding was considered as a unit in two of the three experiments.

Monetary returns above feed costs were dependent on the response of the cows. It increased with groups that gave the larger responses, but monetary returns decreased with groups that gave average or below-average responses.

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BOVINE SEMEN METABOLISM. I. METHODS FOR EXPRESSING FRUCTOLYTIC ACTIVITY [1]

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The ability of sperms to use fructose, independent of initial substrate level and sperm numbers, may be expressed by the regression coefficient of a first-order reaction based on fructose utilizations in successive equal periods of incubation. *Editor.*

The importance of fructose in supporting the metabolic activity of bull sperm has been clearly shown *(9, 10, 11)*. The ability of sperm to utilize sugar is related to the amount of sugar in the semen *(13)*, to the concentration of sperm in the semen, and to the motility and fertility characteristics of the sperm *(2, 3, 7)*. However, the most appropriate method of expressing the rate of fructose utilization has not been clearly shown. Theoretically, one might consider that sperm have two essential attributes in this respect, the first the ability to use an initial maximum amount of fructose in a minute, and the second, the ability to maintain this rate over a period of time with varying degrees of success. Essentially, if the fructose utilization per unit of time (Y-axis) were to be plotted on semilog paper against time (X-axis), the zero-time Y-axis intercept would represent the first attribute (maximum fructose utilization) and the slope of the line would represent the second attribute (fructolysis coefficient). The fructolysis index (milligrams of fructose used per billion sperm per hour at 37° C.) as described by Mann *(11, 12)* would represent essentially a combination of these two measures, being the "area under the curve."

Recently, Hopwood *et al. (7)* presented a concept of fructolytic activity in which the rate of decline in fructolytic activity was the primary consideration. Bull semen was incubated in a phosphate buffer at 37° C. for periods of time up to 3 hours. The fructose level of the semen samples declined with time, and a semilogarithmic plot of the data gave a rectilinear expression of the decline, suggestive of a first-order reaction *(1)*. Hopwood *et al. (7)* pointed out that this was not a true first-order reaction with respect to initial semen fructose levels because the mathematical expression of the rate of decline was markedly affected by the initial level of fructose, which may vary independently of sperm numbers. The authors corrected for the effect of initial fructose level by adjusting the initial level of fructose mathematically to 500 mg. of fructose per 100 ml. of semen and adding (or subtracting) the same amount from fruc-

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tose values determined at subsequent incubation times. The 500-mg. fructose level was arbitrarily selected. A value for K representing the relative rate of decline in fructose content of semen per minute was then calculated. It is clear that the arbitrary level of fructose selected would markedly affect the percentage or fractional rate of decline in fructose level. The frequency distribution of K values determined from a large number of semen samples was skewed and was given a more normal distribution by extracting the square root of the K value. The calculation of a K value for expressing the rate of decline in sperm fructolytic activity according to the method of Hopwood *et al. (7)* seems to give an index figure, empirical in nature, with no rational interpretation but one which does, however, express sperm fructolytic activity in a relative way.

While no true first-order reaction was expressed in regard to the decline in the fructose level of the semen as such, the data of Hopwood *et al. (7)* do support a hypothesis of a true first-order reaction in relation to fructose utilization by the sperm.

Guggenheim *(6)* has presented a formula for expressing the rate of a unimolecular (first-order) chemical reaction which seems to have application to this problem:

$$k = \frac{1}{\Delta t} \log_e \frac{v_2 - v_1}{v_3 - v_2} \qquad (1)$$

The basic feature of this expression is that the rate of the reaction is expressed in terms of $\log_e$ of the ratio of differences in values *(v)* determined at equal time intervals *(t)* during a reaction, thus freeing the expression (rate of reaction) of the concept of initial levels of substrate, which Hopwood *et al. (7)* were unable to do satisfactorily in their report.

The following presentation shows that the rate of decline in fructose utilization by bull sperm may be expressed as a first-order reaction when the fructose utilization data are plotted against the appropriate incubation time intervals. From this the two basic attributes of sperm fructolytic activity already referred to (fructolysis coefficient and maximum fructose utilization) may be calculated by use of first-order regression principles *(1, 6, 8)*. Fructolysis coefficient *(K_V)* may be defined as the fractional decline in sperm fructolytic activity per minute on an instantaneous basis. This may be expressed as a percentage by multiplying K_V by 100. Maximum fructose utilization *(MFU)* may be defined as the milligrams of fructose utilized by 10^9 sperm in 1 minute at zero incubation time, also on an instantaneous basis. Gaines *(4, 5)* has used similar methods in calculating the persistency of milk yields and the theoretical maximum milk yield in dairy cattle.

METHODS

Seventy semen samples, from dairy bulls, having a mean concentration of 1.220×10^9 sperm per milliliter were incubated in a citrate buffer at 37° C. for 1 hour. Fructose determinations were made initially and after 20, 40, and 60 minutes of incubation, these procedures being the same as those used by Erb *et al. (3)* in the Washington studies.

The basic first-order formulas are usually expressed in terms of natural logarithms ($\log_e$). Since the use of common logarithms ($\log_{10}$) is more convenient, the formulas in this paper are expressed in these terms. The constant, 2.303, is used to convert common logarithms to natural logarithms and the constant, 0.4343, is used to convert natural logarithms to common logarithms.

RESULTS AND DISCUSSION

Table 1 presents the mean data on the 70 semen samples, showing the fructose levels in the semen at the various incubation times and also showing the amount of fructose utilized per billion sperm in the successive incubation periods by using a simple proportionality adjustment for sperm numbers. The mean fructolysis index of these samples was 1.738 mg. of fructose.

TABLE I

Mean fructolysis data on seventy semen samples

Incubation time	Fructose concentration	Fructose utilized by 10^9 sperm per incubation period
(min.)	*(mg/ml.)*	*(mg.)*
0	4.96 (V_1)	.....
20	4.08 (V_2)	0.721 (U_1)
40	3.39 (V_3)	0.566 (U_2)
60	2.84 (V_4)	0.451 (U_3)

Figure 1 presents these data graphically, the fructose values being plotted on a logarithmic scale. The utilization *(U)* values fall on a straight line. The *V* values also fall on a straight line, but since, as already indicated, the reaction is not first-order with respect to initial level of fructose, this may be considered as coincidental and largely due to the fact that these are means rather than individual values.

The data from the first two incubation periods were used to illustrate the methods of calculating K_U and *MFU*. K_U may be calculated by use of the following modification of the Guggenheim *(6)* formula:

$$K_U = \frac{2.303\ (\log \frac{U_1}{U_2})}{t_2 - t_1} = \frac{2.303\ (\log U_1 - \log U_2)}{t_2 - t_1} \qquad (2)$$

where U_1 = milligrams of fructose utilized by 10^9 sperm in the first period, U_2 = milligrams of fructose utilized by 10^9 sperm in the second period, t_1 = time of initial sampling, t_2 = time of second sampling, etc., and $t_2 - t_1 = t_3 - t_2$.

Substituting data from the first two incubation periods:

$$K_U = \frac{2.303\ (\log 0.721 - \log 0.566)}{20 - 0} = 0.0121$$

This indicates a mean decline of 1.21% per minute in the fructolytic activity of sperm. The following biological half-life in fructolytic activity was calcu-

lated by a standard formula *(8)* for expressing radioactive decay where the factor 0.693 is $\log_e 2$:

$$T_{1/2} = \frac{0.693}{K_U} = \frac{0.693}{0.0121} = 57.4 \text{ minutes} \quad (3)$$

This half-life value is in itself a measure of the fructolytic activity of semen and is important in assessing how long an incubation period should be. Two 1-hour incubation periods would seem to be ideal if the fructose level of the semen is sufficient to maintain uniform fructolytic activity at a uniformly declining rate over this period of time.

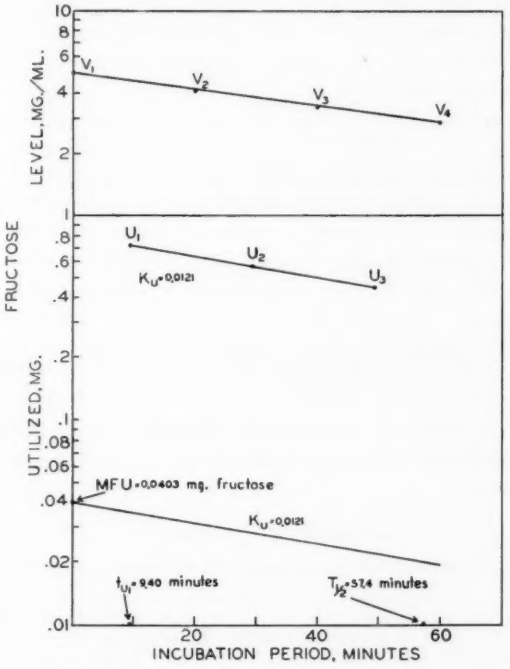

FIG. 1. Relationships among semen fructose level, fructose utilization, and length of incubation period.

In calculating *MFU*, the regression line must be further defined with respect to the time intervals. Up to this point only the slope, K_U, has been calculated and it is necessary to establish the times to which U_1 and U_2 should be assigned. Since U_1 represents the difference between V_1 and V_2, it is appropriate that a time near the middle of the incubation period be selected, but the exact middle, 10 minutes, is not appropriate because more fructose would be utilized in the first 10 minutes than in the second 10 minutes. Thus the time (t_{U_1}) which is to be determined is the time needed to use one-half the fructose utilized in a 20-

minute period. This time changes with differing K_U values and must be determined for each semen sample. If the Y-intercept value (U_0) were known, this time (t_{U_1}) could be calculated with respect to U_0 and U_1. Since U_0 is not known and since in a uniform slope the same relationship would exist between other points at the same time intervals, U_1 and U_2 may be used. Then the desired time (t_{U_1}) would correspond to the difference between U_1 and $U_{1\,1/2}$, $U_{1\,1/2} = \frac{U_1 + U_2}{2}$. Formula 2 may be rearranged to give t_{U_1}:

$$t_{U_1} = \frac{2.303\,(\log U_1 - U_{1\,1/2})}{K_U} = \frac{2.303\,(\log U_1 - \log \frac{U_1 + U_2}{2})}{K_U} \qquad (4)$$

$$= \frac{2.303\,(\log 0.721 - \log \frac{0.721 + 0.566}{2})}{0.0121} = 9.40 \text{ minutes.}$$

It is now possible to calculate MFU which a zero-time, Y-axis intercept value, using known values for $K_U (= 0.0121)$, $U_1 (= 0.721$ mg.)., and t_{U_1} $(= 9.40$ minutes):

$$MFU, \text{ mg.} = \frac{\text{antilog}\,(0.4343 \times K_U \times t_{U_1}) + \log U_1}{t_2 - t_1} \qquad (5)$$

$$= \frac{\text{antilog}\,(0.4343 \times 0.0121 \times 9.40) + \log 0.721}{20 - 0} = 0.0403 \text{ mg. fructose}$$

Formulas 4 and 5 may be combined and simplified to give a more direct calculation of the *MFU* value. In this instance the formula for t_{U_1} is substituted for t_{U_1} in equation 5.

$$MFU, \text{ mg.} = \frac{\text{antilog}\,(2 \log U_1 - \log \frac{U_1 + U_2}{2})}{t_2 - t_1} \qquad (6)$$

$$= \frac{\text{antilog}\,(2 \log 0.721 - \log \frac{0.721 + 0.566}{2})}{20 - 0}$$

$$= 0.0403 \text{ mg. fructose.}$$

Thus, only formulas 2 and 6 are needed to calculate K_U and *MFU*, respectively. A graphic representation of these values is given in Figure 1.

A priori considerations indicaite that K_U is independent of sperm concentration, initial level of fructose in the semen, and the time from ejaculation of the semen to the start of the incubation period. The *MFU*, however, is influenced by the initial level of fructose and the time from ejaculation, but since U values already adjusted for sperm concentration are used, the *MFU* as calculated can also be considered to be independent of sperm concentration effects. Simi-

larly, the indications are that the fertility of semen samples would be negatively correlated with K_V and positively correlated with *MFU*. Thus comparable determinations would require standardization of the above factors. Superior semen samples should have a small K_V and a large *MFU*. Partial and multiple correlation techniques might be used to advantage to relate these measures, together with the index of fructolysis, to fertility.

Since the fructolysis index proposed by Mann *(11, 12)* represents the combined effects of these two independent measures, it may very well be as good a measure of semen quality and fertility for practical application as either or both of the two independent measures. However, for research studies on semen metabolism it would seem that all three values should be determined. It is conceivable that treatments applied to bulls or semen might affect the measures differently, and thus add considerably to an understanding of the mechanisms involved.

The 10-minute calculated fructose utilization proposed by Erb *et al. (3)*, though found to be somewhat more highly correlated with nonreturn rates between bulls than 1-hour utilization, still corresponds to the fructolysis index in representing a combined effect of maximum utilization and rate of decline in utilization. It would seem from this observation that calculation of utilization in the first minute might be correlated even more highly with nonreturn rates than utilization in the first 10 minutes. Such a 1-minute calculated fructose utilization would correspond to *MFU* as proposed in this paper. Since laboratory errors in fructose determinations are relatively much greater for short incubation periods, the longer the period the more accurate is the calculation; that is, with the qualification that there is sufficient fructose present to support the sperm activity until the end of the incubation period. Thus long periods of incubation for the calculation of *MFU* would seem to be most accurate.

SUMMARY

A method has been presented for determining the rate of decline in sperm fructolytic activity per minute (fructolysis coefficient, K_V) in a manner which is independent of the initial fructose levels of the semen, and from which a biological half-life may be calculated. A second index of fructolytic activity (maximum fructose utilization, *MFU*) was also presented in which the initial amount of fructose utilized by 10^9 sperm in 1 minute at zero time was the measure of fructolysis. These measures were based on the concept that the decline in the amount of fructose utilized by sperm in successive time periods is essentially expressed by a first-order reaction, which concept was supported by the data presented and was shown graphically.

The K_V based on the mean performance of 70 semen samples was 0.0121, which indicated that there was a decline of 1.21% per minute in sperm fructolytic activity. The mean biological half-life of these semen samples was 57.4 minutes. The *MFU* was 0.0403 mg. per 10^9 sperm per minute and the fructolysis index was 1.738 mg. or fructose.

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METABOLIC BEHAVIOR OF BOVINE SPERMATOZOA AS INFLUENCED BY BACTERIA[1]

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Bovine seminal plasma showed no metabolic activity, but with Bacillus or Pseudomonas organisms, the oxygen uptake was higher than that of the semen alone, indicating that sperm cells may use the products of bacterial action. *Editor.*

Considerable knowledge of the metabolism of bovine semen has been gained since Walton and Edwards *(12)* in 1938 reported a definite relationship between respiration rates of semen samples and services per conception. They further stated that semen samples with high initial respiration rates retained their motility during storage for a longer period of time than did samples showing lower initial oxygen consumption. This work was later confirmed *(5, 6)*. Mann *(9)* in 1949 reported that the respiration rates of sperm are significantly correlated with their motility. Other workers *(3, 7)*, as well as confirming this, have gone on to state that a study of sperm metabolism may be an important instrument for the accurate evaluation of the fertility of donor bulls in the practice of artificial insemination.

Since the procedure of semen collection for artificial insemination leads to microbial contamination, it may be of great importance in studies on semen to understand the interrelationships between microbial and semen metabolism. Although many workers have reported the numbers of organisms and types of contamination found in collected semen *(1, 2, 4, 8, 10)*, no studies are known in which the effects of microbial metabolism upon semen respiration have been reported. Edmonson *et al. (4)*, upon observing increased longevity of sperm in storage in the presence of micrococci, yeasts, and nonhemolytic streptococci, postulated that either the immediate by-products of microbial metabolism or the utilization of harmful sperm by-products by microorganism accounted for the beneficial effects. Gunsalus *et al. (8)* in 1941 observed the stimulation to semen motility in storage by living *Escherichia coli* but not by killed *E. coli* cultures.

MATERIALS AND METHODS

Metabolic activities of sperm and of selected bacterial genera and their metabolic interaction were measured by oxygen consumption rates in a War-

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burg microrespirometer. The "direct" method *(11)* of oxygen uptake measurement was used by employing a phosphate buffer at pH 7.4, air as the gas phase, and a temperature of 37° C.

The organisms used were a *Bacillus* sp. because it was found to be the predominant contaminating genus in the semen samples, and a *Pseudomonas* sp. also isolated from semen because of its reported detrimental effects upon sperm. The cultures were grown for 24 hours on nutrient agar at 30° C., harvested in phosphate buffer, and diluted to an optical density of approximately 10^6 organism per milliliter.

Semen and seminal plasma samples were obtained from the bulls routinely used at the Colorado A. M. Artificial Breeding Center by means of the standard artificial vagina. All semen was used fresh and was of "very good" quality.

For interaction studies with metabolic products of sperm and bacterial cells, whole semen, whole semen plus organisms, and seminal plasma plus organisms were incubated for 2 hours at 37° C. The incubated samples were filtered through sterile Seitz pads to remove cellular material, and the filtrates were added to fresh phosphate buffer-washed sperm cells.

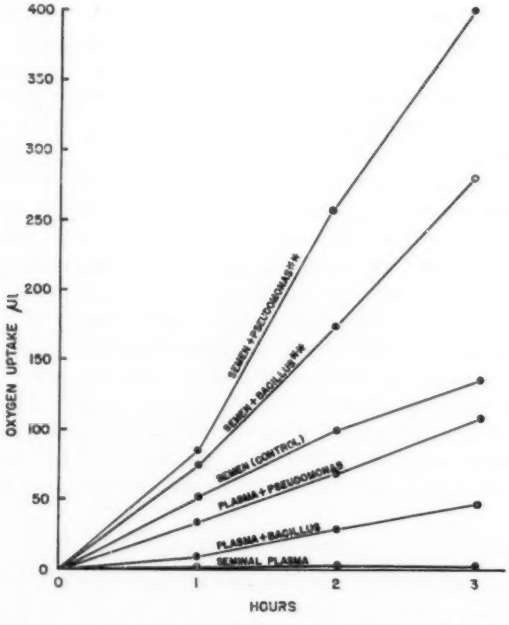

FIG. 1. Effect of *Pseudomonas* and *Bacillus* on the oxygen uptake of bovine semen and seminal plasma. Each flask contained 0.5 ml. of indicated cells, 0.2 ml. 20% KOH in center well and phosphate buffer (pH 7.4) to make total volume of 3.0 ml. Temperature was 37° C. Values are given as typical data assembled from a number of comparable experiments except semen (control) which is an average of the values for the *Bacillus* and *Pseudomonas* experiments.

** 'T' test treated vs. control significant at 0.01 level.

RESULTS AND DISCUSSION

Figure 1 shows a comparison of the 3-hour oxygen uptake curves (average of replicate trials) for whole semen, seminal plasma, and semen and plasma with *Bacillus* and *Pseudomonas* organisms added. It clearly indicates that seminal plasma has little or no oxygen uptake. For this reason plasma was used as substrate for the measurement of respiration of the bacteria. Semen samples to which each of the organisms was added gave oxygen consumption rates greater than can be accounted for by the summation of oxygen used by the whole semen and that used by the organisms. This increase in each case was found to be statistically significant.

Since streptomycin is commonly added to semen before shipment to inseminators in order to suppress bacterial contaminants, it was added to samples to study its effects on the oxygen consumption of both the semen and the organisms. In numerous trials dihydrostreptomycin sulfate (500 γ per milliliter) was shown to have no effect on the oxygen consumption rates of fresh semen samples.

As shown in Table 1, the streptomycin was significantly inhibitory to *Bacillus* organisms. With *Pseudomonas* trials it is interesting to note a slight, but consistent, stimulation to metabolism by the streptomycin. This increase in oxygen uptake was never a significant quantity.

TABLE 1

Effect of streptomycin (500 γ/ml.) on the respiration of bovine semen, Bacillus *and* Pseudomonas

Warburg flask containing[a]	μ l. O_2/3 hr.[c]	Warburg flask containing[a]	μ l. O_2/3 hr.[c]
Semen	154.4	Semen	109.8
Semen + streptomycin	139.2	Semen + streptomycin	100.1
Semen + *Bacillus*[b]	256.1	Semen + *Pseudomonas*	384.1
Semen + *Bacillus* + streptomycin	163.4*	Semen + *Pseudomonas* + Streptomycin	426.7

[a] Each flask contained 0.5 ml. cells, 0.2 ml. 20 per cent KOH, in center well and phosphate buffer (pH 7.4) to make total volume of 3.0 ml. Temperature was 37° C.
[b] Control.
[c] Values are given as typical data assembled from a number of comparable experiments.
* 'T' test of treated vs. control significant at the 0.01 level.

TABLE 2

Effect of metabolic products of Bacillus *and* Pseudomonas *on the respiration of bovine semen*

Warburg flask containing[a]	μ l O_2/3 hr.[d]	Warburg flask containing[a]	μ l O_2/3 hr.[d]
Sperm cells + semen filtrates[c]	92.0[b]	Sperm cellls + semen filtrate	57.9[b]
Sperm cells + filtrate of semen + *Bacilllus*	116.9**	Sperm cells + filtrate of semen + *Pseudomonas*	116.9*
Sperm cell + filtrate of seminal plasma + *Bacillus*	80.7	Sperm cells + filtrate of seminal plasma + *Pseudomonas*	51.4

[a] Each flask contained 0.5 ml. of fresh sperm cells, 0.5 ml. filtrate, 0.2 ml. 20% KOH in center well, and 1.8 ml. phosphate buffer (pH 7.4). Temperature was 37° C.
[b] Controls.
[c] Filtrates were listed ingredients incubated at 37° C. for 2 hours and filtered through sterile Seitz pads.
[d] Values are given as typical data assembled from a number of comparable experiments.
* 'T' test of treated vs. control signiificant at 0.05 level.
** Significant at 0.01 level.

In Table 2 are shown the effects of the metabolic products secreted into seminal plasma by sperm, each organism plus sperm, and each organism alone, upon the oxygen uptake of fresh sperm cells.

After incubation and filtration the cellular-free fiiltrates were used as substrate for fresh sperm. It was determined significantly that the oxygen uptake of sperm cells in the filtrate of incubated whole semen plus *Bacillus* was higher than in the filtrate of whole semen incubated alone. It was also shown that the *Pseudomonas* culture metabolic products also significantly stimulated the oxygen uptake of sperm cells. It seems evident that the intermediate metabolites of organisms studied can serve as metabolic substrate or stimulatory agent for sperm cells.

SUMMARY AND CONCLUSIONS

By using the Warburg microrespirometer to measure oxygen uptake it was shown that bovine seminal plasma has little or no metabolic activity. *Bacillus* or *Pseudomonas* organisms added to semen samples produced an oxygen uptake in 3 hours that was significantly higher than that of semen samples alone or the combined oxygen uptake of semen plus organisms. This indicated a metabolic stimulation to either the sperm cells or bacteria or both. By adding fresh sperm cells to filtrates of incubated bacteria plus semen it was shown that this stimulation was due to the ability of the sperm cells to utilize bacterial intermediate metabolites.

Streptomycin was shown to have little or no effect on the metabolism of sperm cells or on *Pseudomonas* organisms but it was significantly inhibitory to the respiration of a *Bacillus* species.

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FERTILITY OF BOVINE SPERMATOZOA STORED AT MINUS 79° C. FOR ONE WEEK AND FOR SEVENTEEN WEEKS

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Low temperatures are effective in preserving the fertility of bovine spermatozoa for several weeks. Fertility was maintained as well in semen held at about –79° C. for 17 weeks as it was in that held at 5° C. and used within 24-36 hours after collecting and diluting. A kit capable of maintaining semen at –79° C. for 6 days and losing only 2 lbs. of dry ice per day, is described. *Editor.*

A previous report from this laboratory *(2)* indicated that the fertility of spermatozoa stored for 103 days at approximately –79° C. and thawed immediately before breeding was equal to that of unfrozen spermatozoa used for breeding within 24 to 36 hours after collection. Although these results were as satisfactory as any reported up to that time *(3, 5, 6, 7, 17, 23, 24, 25)*, the number of breedings involved was small. Hence, a larger trial was undertaken in an attempt to repeat these results with additional bulls, ejaculates, technicians, and seasons of the year.

EXPERIMENTAL PROCEDURE

Plan of the experiment. The general plan of the experiment was to use split ejaculates collected at successive weekly intervals from six top ranking Holstein sires in the stud of the New York Artificial Breeders' Cooperative, Inc. The unfrozen portions of each ejaculate were used on the day after collection and served as the control. The frozen portions were used after 1 week and 17 weeks storage at approximately –79° C. Since some of these bulls were old and not reliable semen producers, two additional bulls were chosen at the beginning of the experiment to serve as substitutes, if needed.

One hundred forty-nine technicians affiliated with the New York Artificial Breeders' Cooperative, Inc., took part in the field trials. They were divided into groups of three to six men each, and each week two groups of technicians were started on the experiment using the unfrozen portions of the ejaculates on the days after their collection. The following week these same groups used the week-old frozen portions from the first week's ejaculates while two new groups of technicians were started using the unfrozen portions from the second week's

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ejaculates. Later each technician group used 17-week old frozen semen from the same ejaculates that provided their unfrozen and 1-week old frozen semen.

Because facilities were not available for all technicians to use all bulls simultaneously for any one treatment, it was necessary to confound groups of three bulls with groups of technicians. It was also recognized that the experimental plan for using the frozen and unfrozen semen confounded the age of the spermatozoa with the storage temperatures imposed, but such confounding is inherent in the practical application of frozen semen and, therefore, any differences in fertility accompanying these treatments must be interpreted in view of this fact.

In order to have approximately 10×10^6 motile spermatozoa per milliliter of extended semen after freezing and storing for 1 week at approximately –79° C., the number of motile spermatozoa per milliliter of extended semen before freezing was adjusted upwards for each ejaculate as was done in previous studies *(2)* by using each bull's cumulative average survival percentages. No adjustments were made for possible losses of motile sperm after 1 week storage at approximately –79° C.

Composition of extenders. The extenders for the frozen and unfrozen semen were the same as described previously *(2)* and are shown in Table 1.

Pre-extending and cooling the semen to be frozen. The quantity of semen required to provide the desired number of motile spermatozoa per milliliter of final extended semen was pre-extended with nonglycerol extender at 30° C. and then cooled to 5° C. during a period of 75 minutes *(11)*. After cooling, the pre-extended semen was made up to one-half the final volume with 5° C. nonglycerol extender.

Glycerolating and equilibrating the semen. The glycerol extender at 5° C. was added to the nonglycerol extended semen in increments of 10, 20, 30, and 40% of the remaining half-final volume at 20-minute intervals. Each added increment was mixed with the partially glycerolated semen by gentle end-over-end rotation of the cylinder. The spermatozoa then were allowed to equilibrate in this final 7% glycerol extender for a period of 5 hours before freezing.

TABLE 1

Composition of buffers and extenders[a]

Extenders	Concentration of citrate, glycerol, and sulfanilamide in buffers			Proportion of egg yolk in buffers	Concentration of citrate, glycerol, and sulfanilamide in extenders[b]		
	C	SA	GL[c]	Y:B	C	SA	GL[c]
	(%)	(%)	(%)		(%)	(%)	(%)
2.9CSAY	2.9	0.6	——	1:1	1.45	0.3	——
2.9CY[d]	2.9	——	——	1:4	2.32	——	——
2.9CYGL[d]	2.9	——	17.5	1:4	2.32	——	14.0

[a] 2.9 refers to the per cent of sodium citrate dihydrate in the buffer. C = citrate; SA = sulfanilamide; GL = glycerol; Y = hens' egg yolk; B = buffer.

[b] Each extender contained 500 units each of penicillin and streptomycin per milliliter of extender.

[c] By weight, using a sp. gr. for glycerol of 1.25.

[d] Addition of the 2.9CYGL to the 2.9CY during the glycerolating process gave a final extender containing 7% glycerol by weight.

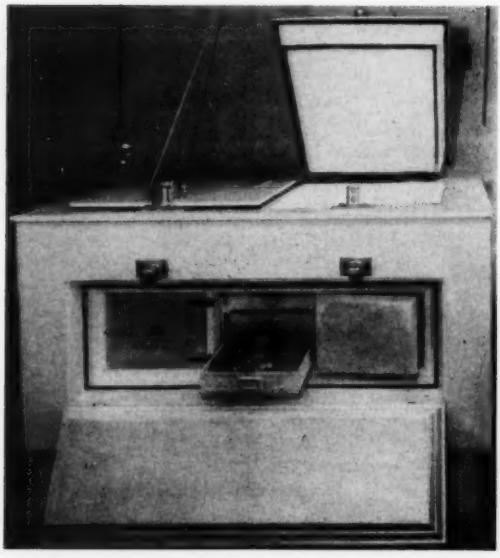

FIG. 1. Frozen semen storage unit with Dry Ice bunker in top and ampule can storage trays. Used for bulk storage at a temperature of approximately −79° C.

Ampuling the extended semen. During the equilibration period approximately 1.1 ml. of the glycerolated semen was dispensed by gravtiy into cold (5° C.) 2-ml. glass ampules,[2] by using sterile glass funnels, short rubber connectors, and No. 12 gauge needles. The ampules were sealed with a Popper[3] sealer and placed in triangular baskets made of ¼-in. mesh hardware cloth. Four baskets, each holding 10 ampules, were placed in tin cans 2¾ in. high and 4 in. in diameter. Enough 5° C. ethyl alcohol was placed in these cans to submerge the body of the ampules.

Freezing and storing the semen. The ampules were carried in these tin cans from the 5° C. room to a 27° C. room and the baskets of ampules were quickly transferred to a 5° C. freezing bath. Powdered Dry Ice then was added slowly to the bath to lower its temperature approximately 0.8° C. per minute from 5° C. to −15° C. When the temperature reached −15° C., Dry Ice was added rapidly and the temperature was lowered from −15° C. to −79° C. in about 15 minutes. The total freezing time averaged approximately 40 minutes.

The baskets of frozen ampules were transferred quickly from the freezing bath to storage cans containing −79° C. alcohol and stored at approximately −79° C. in the unit shown in Figure 1.

Each technician's allotment of ampules from each bull for the 1-week old and the 17-week old frozen semen breedings were transferred to separate storage

[2] Hughes-Murray, Inc., Item A-88-D, tapered, molded ampules.
[3] Popper and Sons, Inc., Labseal, Model HS-1.

cans at this time to facilitate the transfer of the ampules from storage to the technician's frozen semen kit without removing the ampules from the alcohol in the cans.

Motility of frozen samples before using. The percentage of motile spermatozoa in the frozen semen immediately after freezing was estimated from two ampules randomly chosen from each ejaculate, thawed in 40° C. water, and examined by the routine procedures of this laboratory. Just prior to the time the frozen semen kits were loaded for delivery to the technicians, two more ampules were examined. The average percentage of motile spermatozoa at this time served as a crude basis for judging whether or not an ejaculate should be used for breeding purposes.

Transporting and storing the frozen semen in the field. The frozen semen kit used to transport the ampules of frozen semen from the laboratory to the technicians and from farm to farm by the technicians contained two 1-gal. wide-mouth Dewar flasks, a 1-qt. vacuum bottle for warm water, a 50-ml. plastic thawing tube, ampule files, and a thermometer. The kit is shown in Figure 2.

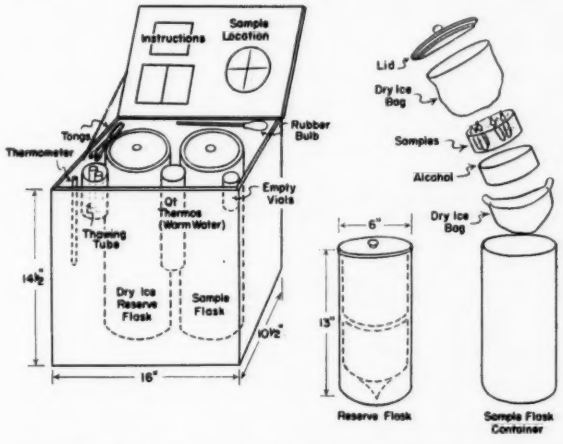

FIG. 2. The technician's frozen semen kit showing the arrangement of inserts within the Dewar flasks.

One of the Dewars served as a reserve for Dry Ice that could be transferred as needed to the Dewar containing the ampules of frozen semen. A small amount of powdered Dry Ice was placed beneath and around the cans of ampules in the Dewars. Finally, a bag of Dry Ice was placed on top of each can to fill the Dewar.

Services and nonreturns. The fertility of the semen was calculated on the basis of the percentage of first service cows not returning for reinsemination within 28 days after the week in which they were inseminated (28- to 35-day nonreturns), and within 60 days after the end of the month in which they were inseminated (60- to 90-day nonreturns).

TABLE 2

Semen data by bulls before and after freezing

Sire	Fresh unextended semen			Unfrozen[a] semen (control)		Frozen semen used for breeding							
						Immed. before freezing		Immed. after freezing		After 1 week at −79° C.		After 17 weeks at −79° C.	
	Number of ejac. per bull	% motile sperm	10^6 sperm per ml.	% motile sperm	10^6 sperm per ml.	% motile sperm	10^6 sperm per ml.	% motile sperm	10^6 sperm per ml.	% motile sperm	10^6 sperm per ml.	% motile sperm	10^6 sperm per ml.
1	13	56	1,084	49	8.8	56	16.9	46	14.3	46	14.1	35	10.9
2	13	59	866	52	8.7	59	13.9	47	11.0	43	10.2	41	9.6
3	13	66	1,290	55	8.2	66	16.9	44	11.3	45	11.8	35	8.4
4	13	67	1,275	58	8.6	67	13.9	57	11.9	57	11.7	43	9.0
5	12	56	2,153	47	8.5	56	13.8	45	11.1	45	11.3	35	8.8
6	6	58	1,598	48	8.2	42	13.4	44	10.1	43	10.0	42	9.6
7	2	60	1,759	55	9.2	60	17.9	42	13.4	42	13.4	27	6.2
8	3	63	2,189	57	9.0	63	12.5	53	10.4	52	10.2	48	8.9
Total	75												
Mean		61	1,389	51	8.6	59	14.9	47	11.7	47	11.6	38	9.3

[a] Unfrozen control contained no glycerol; % motile sperm represent estimations made about 30 hours post-collection.

RESULTS AND DISCUSSION

With the exception of an occasional ejaculate which did not meet the routine standards for unfrozen semen, all ejaculates collected from the bulls during the experiment were processed, placed in storage, and used.

In Table 2 are data pertaining to the average concentration and percentage of motile spermatozoa in the fresh unextended semen, the percentage of motile spermatozoa, and the number of motile spermatozoa per milliliter of extended semen at different stages of processing and storage. Of particular interest is the number of motile spermatozoa per milliliter of extended semen originally planned (10×10^6) and the estimated numbers achieved, 8.6×10^6, 11.6×10^6, and 9.3×10^6, for the unfrozen, 1-week frozen, and 17-week frozen semen, respectively.

The spermatozoan survival percentages for individual ejaculates after 1 week storage ranged from 46 to 82 and averaged 77. The average survival percentage after 17 weeks storage was 62.

The fertility results are shown in Table 3. On the basis of a t test *(14)* there were no significant differences between the 60- to 90-day nonreturn rates: $P > 0.6$ for unfrozen vs. 1-week frozen, $P > 0.3$ for unfrozen vs. 17-week frozen, and $P > 0.4$ for 1-week frozen vs. 17-week frozen.

TABLE 3

Fertility of unfrozen and frozen semen

	Unfrozen control			Frozen					
	Used after 1 day at +5° C.			Used after 1 week at −79° C.			Used after 17 weeks at −79° C.		
Sire	Total 1st serv.	25-35 day % N.R.	60-90 day % N.R.	Total 1st serv.	25-35 day % N.R.	60-90 day % N.R.	Total 1st serv.	25-35 day % N.R.	60-90 day % N.R.
1	224	80.8	71.6	208	83.7	74.0	185	86.5	73.0
2	253	83.3	66.7	194	77.5	73.2	192	74.5	68.2
3	205	84.9	76.4	205	84.4	76.6	200	80.5	68.0
4	190	80.0	72.1	180	80.0	74.4	187	80.7	72.2
5	212	71.7	60.0	212	77.4	67.0	189	73.0	66.7
6	128	82.8	75.0	94	83.0	76.6	82	85.4	79.3
7	14	71.4	73.3	16	62.5	56.2	17	76.5	64.7
8	37	94.6	84.8	42	85.7	76.2	42	71.4	59.5
Total	1278			1151			1094		
Average		79.9	71.0		82.0	73.2		79.2	69.8

Average 60- to 90-day nonreturns for the total of 2,245 first services to frozen semen; 71.5%.

Gross, among, and within bull linear correlation coefficients were computed for all appropriate combinations of spermatozoan numbers and per cent nonreturns, but the magnitudes of these correlations were so erratic as to preclude their use for predicting nonreturn rates of ejaculates of frozen semen prior to their use. Such results might be anticipated because of the relatively few observations available from this experiment to reliably estimate such relationships.

The average loading of Dry Ice for each of the 12 technicians' frozen semen kits was 6,815 g. (15 lb.). Of this amount an average of 5,903 g. (13 lb.), 87%

of the original loading, evaporated between the time the kits left the laboratory at the New York Artificial Breeders' Cooperative, Inc. and the time they were returned, about 6.5 days later. Since no Dry Ice was added to the kits during this time, the average Dry Ice loss per kit per day for 12 round trips made from January 5, 1954, to March 28, 1954, was 1.9 lb., and for 12 round trips made from May 5, 1954, to July 25, 1954, was 2.1 lb. The latter rate of loss reduced to the critical point the margin of safety for a once-a-week reicing schedule during the warmer months of the year in this region of the United States. In one instance the Dry Ice in the sample flask of one kit was nearly gone upon its return to the laboratory. At this time the temperature of the alcohol in the flask was –72° C. From this and occasional random checks of the temperature in the returned flasks it was concluded that generally the temperatures in the sample flasks were close to –79° C. Although it is not likely that the full Dry Ice loading would last as long if the kits were used seven days a week instead of three, as in these trials, additions of Dry Ice every three or four days certainly would be sufficient to avoid undue risks. With such a precaution, these kits, which are relatively inexpensive to construct and to operate, offer considerable opportunity for testing the fertility of frozen semen under field conditions.

The fertility results in these experiments confirm the earlier satisfactory results obtained with frozen semen by this laboratory *(2)* and are slightly higher than most of the recent reports on the fertility of frozen semen *(4, 8-10, 12, 14-16, 18-22, 26-30)*. It is recognized, however, that more research needs to be directed toward the routine use of frozen semen under different operating conditions. Of particular urgency is more knowledge concerning the cause and prevention of the 20 to 60% loss of spermatozoa during the freezing process and the first few days of storage, the loss of motility during long time storage at –79° C. and the relationship of spermatozoan numbers to fertility when using frozen semen. In addition, there are the problems of economical storage and handling of frozen semen at both the stud level and in the field if frozen semen is to become competitive with unfrozen semen.

SUMMARY

In a split-ejaculate experiment involving 75 ejaculates from eight Holstein sires during two 3-month experimental periods, the 60- to 90-day percentage nonreturns was 71.0 for 1,278 first services to unfrozen semen, 73.2 for 1,151 first services to frozen semen stored 1 week at –79° C., and 69.8 for 1,094 first services to frozen semen stored 17 weeks at –79° C. These differences, which were not significant even at the 10% level of probability, confirm the previous results with frozen semen reported from this laboratory. The average spermatozoan survival rate for all ejaculates was 77% after 1 week storage and 62% after 17 weeks storage at –79° C. The estimated number of motile spermatozoa per milliliter of extended semen at the time of breeding was 8.6×10^6, 11.6×10^6, and 9.3×10^6 for the unfrozen, 1-week frozen, and 17-week frozen semen, respectively. Within treatments, there were no significant and useful correla-

tions between the number of spermatozoa inseminated and fertility. A frozen semen kit capable of maintaining a temperature of approximately −79° C. for 6 days with a loss of 2 lb. of Dry Ice per day is described.

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VALUE OF ALFALFA SILAGE IN THE DIET OF THE YOUNG DAIRY CALF [1, 2]

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Alfalfa hay and its silage were fed to calves singly and in combination as roughages and the results were measured in growth responses. The silage was equal to either the hay or hay-silage combination. Growth and TDN consumption paralleled each other regardless of the roughage fed. *Editor.*

Texts on dairy cattle feeding and management through the years have indicated generally that silage was of little value for the dairy calf; however, a review of the literature yields little scientific data as to the value of high quality hay-crop silage for nutrients for the young calf. Sykes *et al. (10)* have reported on a comparison of alfalfa hay and alfalfa silage for dairy heifers from birth to 24 months of age, in a limited milk and grain feeding system. They concluded that high levels of alfalfa silage would not promote normal growth. Their data show, however, that treatment differences relative to growth were slight up to 5 months of age and most pronounced from 5 to 12 months of age.

Poor or average quality hay has been found inadequate for the young dairy calf raised under a limited whole milk and grain system of feeding *(2, 3, 4)*. The weather in the northeastern states is a constant threat to the harvesting of high quality field-cured hay *(1, 8)*. Many dairymen now produce good quality hay-crop silage year after year, regardless of poor hay-drying conditions. It appears conceivable that the over-all level of the quality of roughage being fed to young dairy animals might rise more rapidly if hay-crop silage could be utilized satisfactorily in their rations.

The objectives of the present study were to determine:

1. The feasibility of feeding high quality alfalfa silage as the only source of roughage to calves.

2. The effect of supplementing alfalfa hay with alfalfa silage in the ration of calves.

3. The efficacy of feeding maximum levels of roughage to calves while restricting concentrate intake.

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[2] The data in this paper are in part from a thesis submitted by the senior author to the Graduate School of The Pennsylvania State University in partial fulfillment of the requirement for the degree of Doctor of Philosophy.

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EXPERIMENT I

Experimental procedure. Forty-eight Holstein calves (30 males and 18 females), weighing between 85 and 115 lb., obtained from the University research herd, eight Pennsylvania State institutional herds, and local farmers, were used in this experiment, which was run from January through July, 1954.

Upon arrival at the University calf research barn, the calves were weighed and randomly assigned with restriction as to sex, to one of six ration treatments. As a scours preventive, each calf received two 5-g. sulfathaladine tablets at time of arrival and one tablet at each of its next two feedings. The calves were placed in individual stalls with solid partitions, and the barn temperature was maintained at a minimum of 55° F. The barn was artificially heated and equipped with a ventilation system. Wood shavings or a combination of shavings and sawdust were used for bedding. Fresh water was available at all times.

The limited milk-starter method of feeding was followed. Whole milk from a Holstein herd was fed through 42 days of age at a daily rate of 9% of the initial body weight determined at 6 days of age.

The three basic roughage treatments were *(a)* alfalfa hay, *(b)* alfalfa silage, and *(c)* alfalfa hay and its silage. All roughage was fed ad libitum. These roughage treatments were tested at 2 and 5 lb. maximum daily starter levels. Five males and three females were randomly assigned to the six treatments and fed for 16 weeks as follows: Treatment 1—alfalfa hay, starter 5 lb.; Treatment 2—alfalfa silage, starter 5 lb.; Treatment 3—alfalfa hay and alfalfa silage, starter 5 lb.; Treatment 4—alfalfa hay, starter 2 lb.; Treatment 5—alfalfa silage, starter 2 lb.; Treatment 6—alfalfa hay and alfalfa silage, starter 2 lb. The roughage was fed as above at a rate sufficient to provide a 5 to 10% weighback each day. All feeds were weighed to the nearest 0.1-lb. Respective roughages and starter were offered to the calves from the time they entered the experiment at six days of age.

An attempt was made to provide uniform feedstuffs throughout the trial. Enough starter was mixed at one time to meet the requirements of the trial. The starter used was one which previously had given good results at this Station; its composition is given in Table 1. A field of second-growth alfalfa was divided into two sections; one portion was harvested and stored as field-cured hay and the other as silage, in an upright silo. The relatively small quantity of silage stored did not preserve satisfactorily and, therefore, the majority of the silage fed was alfalfa silage, stored at the University Dairy Production Center. As a result, the roughage lacked desired uniformity to some degree. The average chemical composition of the feedstuffs is presented (Table 2) and represents mean values of monthly composite samples taken during the experimental period.

Records were maintained relative to all feed offered and refused. Total digestible nutrient consumption was calculated by applying appropriate coefficients of digestibility from Morrison *(6)* to the feedstuff proximate analysis

TABLE 1
Starter formulas used

Ingredient	Experiment I	Experiments II and III
	(lb.)	*(lb.)*
Yellow corn meal	400.0	750.0
Wheat bran	300.0	300.0
Crushed oats	400.0	406.0
Linseed oil meal	140.0	100.0
Soybean oil meal	290.0	100.0
Dehydrated alfalfa meal	140.0	100.0
Cane molasses	100.0	100.0
Dried skimmilk	100.0	100.0
Dried corn distillers solubles	100.0	
Dicalcium phosphate	10.0	
Ground limestone	10.0	
Iodized salt	10.0	20.0
Vitamin A feeding oil	3.0	
Irradiated yeast	0.5	
Vitamin A and D supplement		4.0
Mineral mixture		20.0

data. Where applicable, data were analyzed statistically according to the methods of Snedecor *(9)*.

Growth measurements, consisting of body weight, height at withers, and chest and barrel circumference, were recorded weekly.

In an attempt to ascertain treatment effects on rumen fluid fiber digestion, rumen fluid samples were obtained by use of a stomach tube at 8, 10, and 12 weeks of age. Fiber breakdown was studied by means of the miniature artificial rumen technique as reported by Huhtanen and Gall *(5)*.

To study the effect on reticulo-rumen development of alfalfa hay versus alfalfa silage as the sole source of roughage, the five male calves on Treatments 1, 2, 4, and 5 were sacrificed at 16 weeks of age, and reticulo-rumen capacity and wet weight were determined. The male calves from Treatments 3 and 6 were removed from experiment at 16 weeks of age, but were not slaughtered because of a need for them in other research.

TABLE 2
Average chemical composition of feedstuffs used

Feedstuff	As fed					
	Moisture	Ash	Ether extract	Crude fiber	Crude Protein	N.F.E.
	(%)					
Experiment I						
Starter	10.34	5.92	3.03	7.95	20.41	52.35
Alfalfa hay	8.95	7.24	2.24	27.02	18.54	36.01
Alfalfa silage	72.00	2.64	1.03	8.58	5.13	10.62
Experiments II and III						
Starter	6.62	5.68	3.09	6.95	16.13	61.54
Alfalfa hay	5.69	8.04	2.17	24.59	19.98	39.53
Alfalfa silage	71.40	2.82	1.22	7.17	5.90	11.42

Results and Discussion. As noted previously, each treatment was tested with five male and three female calves. Sex differences have not been elaborated, because statistical treatment showed sex variation to be nonsignificant. Data relative to this experiment are given (Table 3).

TABLE 3

Value of alfalfa silage in the diet of young Holstein calves. Experiment I. Mean data

Criteria	Treatments[a]					
	Max. concentrate 5 lb. per day			Max. concentrate 2 lb. per day		
	1 Alfalfa hay	2 Silage	3 Hay and silage	4 Alfalfa hay	5 Silage	6 Hay and silage
Gain[b] in body wt. *(lb.)*	176.4	162.5	172.3	130.3	128.0	142.3
Gain in height at withers *(cm.)*	18.0	16.8	17.9	14.6	14.3	15.1
Gain in chest circumference *(in.)*	11.3	11.0	11.2	9.2	9.3	10.0
Gain in barrel circumference *(in.)*	22.4	21.8	22.3	20.0	19.8	21.0
Gain in body wt. *(% of Ragsdale standard)*	114	107	112	86	85	91
Gain in height at withers *(% of Ragsdale standard)*	112	105	111	92	91	96
Gain in chest circumference *(% of Ragsdale standard)*	99	100	100	83	84	91
Dry matter consumption, 6–112 days *(lb.)*	489	426	488	397	363	425
TDN Consumption, 6–112 days *(lb.)*	376	336	373	288	265	302
In vitro per cent fiber digestion, 8 weeks	54	56	51	53	51	50
In vitro per cent fiber digestion, 10 weeks	56	56	61	58	60	52
In vitro per cent fiber digestion, 12 weeks	55	56	59	54	54	59
Reticulo-rumen wet weight *(lb.)*	7.2	6.1	—	5.3	5.6	—
Reticulo-rumen capacity *(liters)*	16.0	14.6	—	12.8	13.0	—

[a] Five male and three female Holstein calves per treatment.
[b] All gains are reported as between six and 112 days of age.

Within concentrate levels, body weight, height at withers, and chest and barrel circumference variation was not significantly affected by treatment. On the other hand, the superior growth of the high concentrate calves was significant at the 1% probability level, excepting barrel circumference, which showed significance only at the 5% level. It will be noted (Table 3) that the growth response of the calves fed alfalfa silage as the sole source of roughage was comparable to, though slightly lower than, growth response when the roughage source was either alfalfa hay or alfalfa hay and alfalfa silage fed in combination. This was evidenced at both concentrate levels. Skeletal growth differences within a concentrate level were not discernible during the trial; however, the alfalfa silage–fed calves carried somewhat less flesh (see data, Table 2). The growth response of the calves on Treatments 1, 3, 4, and 6 strongly suggests that equally good growth may be expected during the first 16 weeks of life by Holstein calves, whether the roughage source is alfalfa hay alone or alfalfa hay and alfalfa silage fed free choice. These data indicate that the dairyman with a limited

amount of good quality hay and having good quality alfalfa silage available would probably be practicing sound management to utilize the silage in the calf-feeding program. If only poor or average quality hay is available, the possibility exists that the feeding of high quality alfalfa silage as the sole roughage source might promote more satisfactory growth.

Body weight, height at withers, and chest circumference changes from 6 to 112 days of age are presented in Table 3 as percentages of the Ragsdale standard *(7)*. The high-concentrate calves surpassed the standard at 112 days of age in both body weight and height at withers; whereas, growth as measured by chest circumference closely approximated the standard. The growth response of the low-concentrate calves generally was below the Ragsdale standard throughout the experimental period.

It will be noted in Table 3 that within concentrate levels the alfalfa silage–fed calves (Treatments 2 and 5) consumed markedly less dry matter and digestible nutrients than did calves fed either hay alone or hay and silage in combination. This lower dry matter and TDN consumption for silage-fed calves was significant at the 1% level, with the exception of Treatment 4 *vs.* 5, which only approached the 5% level of probability. The significantly lower dry matter and TDN intake for calves fed alfalfa silage as the only roughage is of especial interest when viewed in light of the growth response, where the treatment variation within concentrate levels was not statistically significant. Such results would tend to suggest more efficient nutrient utilization when the alfalfa silage constituted the roughage source regardless of concentrate level. The growth of the hay-fed calves and those having access to both hay and silage paralleled TDN intake.

By limiting Holstein calves to a 2-lb. daily starter intake in this trial, roughage consumption was markedly increased. Calves on the 2- and 5-lb. levels of starter feeding consumed, respectively, 49 and 23% of their TDN intake in the form of roughage during the experimental period. The TDN derived from milk was excluded from the above percentages. The increased roughage consumption occurred while the calves were ingesting approximately one-half as much total starter as those on the 5-lb. maximum daily starter level. However, the increased roughage intake for the low-concentrate calves was not sufficient to overcome the TDN differential created by the varied starter levels, and significantly lower growth response resulted. Calves on Treatments 3 and 6, which were fed alfalfa hay and alfalfa silage free choice, obtained from hay 69% of the TDN derived from roughage.

Since information relative to the effect on fiber digestion of a high proportion of grass silage in the young calf ration was lacking, it was deemed desirable to study rumen fluid fiber digestion during the final half of the experiment. The in vitro per cent fiber digestion results as obtained through use of the miniature artificial rumen *(5)* are given (Table 3). The fiber digestion of the rumen fluid sampled at 8, 10, and 12 weeks of age was not altered significantly by treatment. Fiber digestion was generally higher at 10 and 12 weeks of age

than at 8 weeks of age. This age effect was significant at the 5% level. Though Sykes *et al. (10)* did not study the capacity of the rumen flora to digest fiber, they did compare the bacterial flora of alfalfa silage–fed yearling heifers with that of mature cows on a ration of alfalfa hay, and noted much similarity in the rumen flora of both groups of animals. From the work cited above and the present research, it would appear that the form of roughage fed to growing dairy animals has a limited effect upon either the type of rumen flora established or their fiber digestion capacity.

In an attempt to determine the effect of rations containing a high degree of succulence on reticulo-rumen development, the five male calves on Treatments 1, 2, 4, and 5 were sacrificed at 16 weeks of age. The reticulo-rumen measurement results are given in Table 3. The variation due to form of roughage fed was not significant. The effect of concentrate level was significant at the 5% level. Individual variation was so great with regard to reticulo-rumen capacity that the between-concentrate level differences failed to exhibit significance. Despite the fact that the low-concentrate calves consumed up to 54% more roughage than calves on the 5-lb. daily starter level, barrel circumference and reticulo-rumen wet weight and capacity were lower.

EXPERIMENT II

From the results of Experiment I, it appeared that the feeding of high quality alfalfa silage to the young dairy calf, either with alfalfa hay or as the sole source of roughage, was a feasible practice. However, since there was a small growth advantage in favor of hay-fed calves, it appeared that further verification of the results was needed. The data relative to the two starter levels suggested that despite markedly increased roughage consumption, a 2-lb. maximum daily starter intake was not a level conducive to satisfactory growth response. Therefore, it seemed desirable to conduct another trial to *(a)* test further the feasibility of the use of alfalfa silage in the diet of the young dairy calf, and *(b)* attempt to provide a starter level that would induce maximal roughage intake and still effect normal growth.

Experimental procedure. Thirty-six male Holstein calves were utilized in this experiment, conducted from October, 1954, through April, 1955. Details relative to animal sources, selection, housing, and care were analogous to Experiment I. The calves entered the experiment at eight days of age.

The 36 calves were randomly assigned to three treatments and fed for 16 weeks as follows: Treatment 1—alfalfa hay ad lib.; Treatment 2—alfalfa silage ad lib., and Treatment 3—alfalfa hay and alfalfa silage ad lib. All calves were fed starter up to a maximum daily intake of 3 lb. The procedure in regard to feeding, consumption records maintained, feed sampling, and data treatment was similar to that of Experiment I, with the exception of milk feeding. (A milk replacer was used instead of whole milk.) Growth measurements identical to those used in the first trial were recorded at eight days and six and 16 weeks of age. These measurements were recorded for three consecutive days, and the average was utilized as the experimental measurement.

Since roughage uniformity was lacking to some degree in the initial trial, a concerted effort was made to effect maximal uniformity in this subsequent experiment. An 8 ft. by 30 ft. upright silo was erected at the calf research barn. The hay and silage were harvested from two adjacent fields of second-growth alfalfa. The hay was cured without any rain. The silage, treated with 8 lb. of sodium metabisulfite per ton of green material and thoroughly packed between loads, was preserved satisfactorily. The average proximate chemical analyses, as well as the observed physical appearance and odor of both hay and silage, indicated that the roughage fed was of high quality.

The consumption data from Experiment I showed that the low-level starter calves were ingesting ample protein based on the Morrison standard *(6)*. Because of the relatively high crude protein content of the roughage available, it seemed advisable to decrease the digestible protein level of the starter from about 17 to 12%. Because of the growing interest in the use of milk replacers, a commercial milk replacer was used in lieu of whole milk as fed in Experiment I. This replacement consisted of 50% dried skimmilk, 15% dried whey, 10% distillers corn solubles, 10% oat flour, 7.6% dextrose, 5% dried brewers yeast, and 2.3% minerals, vitamins, and antibiotic supplement. It was fed as a warm water suspension between 6 and 42 days of age. A total of 38.8 lb. of dry replacement was fed during this period. Whole milk feeding was limited to 4 lb. daily between the 6th and 10th days, with none being fed thereafter.

Results and discussion. In this trial with Holstein male calves limited to a maximum daily starter intake of 3 lb., similar as well as satisfactory growth response was obtained from 8 through 112 days of age, whether the roughage portion of the ration was alfalfa hay alone, alfalfa silage alone, or alfalfa hay and silage fed in combination. Data showing the average growth performance of the 12 calves on each of the three treatments will be found in Table 4. Growth response in this trial with regard to roughage treatment tended to corroborate the findings of Experiment I.

The 3-lb. maximum daily starter level was utilized in this experiment in an attempt to stimulate roughage consumption as well as effect acceptable growth response. By comparison with the Ragsdale standard, it can be noted (Table 4) that growth as measured by body weight, height at withers, and chest circumference closely approximated the standard at 16 weeks of age. Such performance suggests that a 3-lb. maximum daily starter intake is probably adequate for Holstein calves on a high quality ad libitum roughage feeding regime.

Dry matter and TDN intake (as shown in Table 4) was similar for calves fed either alfalfa hay as the sole source of roughage or alfalfa hay and silage fed free choice. When alfalfa silage constituted the only roughage source, both dry matter and TDN consumption were significantly lower ($P = < 0.01$). These results are analogous to the data of the initial trial with regard to roughage treatment. As in Experiment I, the data of the present trial indicate a higher degree of nutrient utilization for the alfalfa silage–fed calves since growth performance was comparable to that with the other treatments while dry matter

TABLE 4

Value of alfalfa silage in the diet of young Holstein calves. Experiment II. Mean data

Criteria	Treatments[a] 1 Alfalfa hay	2 Silage	3 Hay and silage
Gain[b] in body weight *(lb.)*	161.8	153.5	160.9
Gain in height at withers *(cm.)*	16.3	15.2	15.4
Gain in chest circumference *(in.)*	11.1	10.5	10.7
Gain in barrel circumference *(in.)*	21.7	20.5	21.6
Gain in body weight *(% of Ragsdale standard)*	103	99	104
Gain in height at withers *(% of Ragsdale standard)*	105	97	99
Gain in chest circumference *(% of Ragsdale standard)*	99	94	96
Dry matter consumption, 8–112 days *(lb.)*	532	475	524
TDN consumption, 8–112 days *(lb.)*	363	322	351

[a] Twelve male Holstein calves per treatment.
[b] All gains are reported as between eight and 112 days of age.

and TDN consumption were significantly lower. The calves that had access to alfalfa hay and silage consumed 45% of the TDN from roughage in the form of hay. This is in contrast to the first trial, in which the calves fed hay and silage ingested 69% of the TDN from roughage in the form of hay.

EXPERIMENT III

With evidence available indicating that the Holstein calf is capable of attaining normal growth when good quality alfalfa silage is fed as the only source of roughage from birth, it seemed desirable to investigate the ability of calves of a lighter breed to utilize high levels of alfalfa silage in the diet.

Experimental procedure. Ten male Guernsey calves were placed on trial at eight days of age in this experiment, which was carried out from November, 1954, through April, 1955. The calves were obtained from private herds in Clearfield County. The housing, care, and selection of animals were essentially the same as in Experiment II.

Because of limited numbers, instead of utilizing the three basic roughage treatments used in Experiments I and II, the ten calves were randomly assigned with restriction as to body weight to two treatments and fed for 16 weeks as follows: Treatment 1—alfalfa hay ad lib., and Treatment 2—alfalfa silage ad lib. The treatment providing free choice of both hay and silage was excluded in this trial, as it was considered the least stringent test of the calves' ability to utilize alfalfa silage. Starter intake was limited to 3 lb. daily. Other details relative to feed consumption records, growth measurements, and data treatment were analogous to Experiment II. All feeds were from the same sources as those fed in Experiment II.

Results and discussion. The growth response of Guernsey male calves with alfalfa silage serving as the sole source of roughage was similar to that obtained

when alfalfa hay was fed as the only forage. Both treatments were tested with five male calves from 8 through 112 days of age. None of the growth differences found were statistically significant (Table 5). One of the silage-fed calves failed

TABLE 5

Value of alfalfa silage in the diet of Guernsey calves. Experiment III. Mean data

Criteria	Treatments[a] 1 Alfalfa hay	2 Silage
Gain in body weight, 8–112 days *(lb.)*	121.8	127.6
Gain in height at withers, 8–112 days *(cm.)*	15.2	13.9
Gain in chest circumference, 8–112 days *(in.)*	9.7	9.9
Gain in barrel circumference, 8–112 days *(in.)*	18.2	19.3
Gain in body weight, 8–112 days *(% of Ragsdale standard)*	113	115
Gain in height at withers, 8–112 days *(% of Ragsdale standard)*	104	94(99)[b]
Gain in chest circumference 8–112 days *(% of Ragsdale standard)*	101	104
Dry matter consumption *(lb.)*	399	389
TDN consumption *(lb.)*	279	271

[a] Five male Guernsey calves per treatment.
[b] Figure in parentheses excludes calf No. 85.

to gain normally in height at withers, despite showing satisfactory growth with respect to the other measures; consequently, the average gain in height at withers for the calves in Treatment 2 was noticeably lower. The experimental period gains expressed in Table 5 as percentages of the Ragsdale standard indicate the normalcy of the growth performance of the calves on both treatments. When the height at withers data for calf No. 85 was excluded, the growth response of the calves in Treatment 2 more closely approximated the standard, as indicated by the parenthetical percentage in Table 4.

The consumption of dry matter and TDN was similar for both treatments (see Table 5). Whereas the feeding of alfalfa silage as the only roughage source to Holstein calves in Experiments I and II resulted in significantly lower dry matter and TDN intake, when compared to calves receiving alfalfa hay, it is interesting to note that differences were not significant with the Guernsey calves studied in this work.

SUMMARY AND CONCLUSIONS

In three experiments, the value of high quality alfalfa silage in the diet of the young dairy calf was studied with Holstein or Guernsey calves. The feasibility of feeding high quality alfalfa silage as the only source of roughage, as well as the effect of supplementing alfalfa hay with alfalfa silage, was investigated at 2-, 3-, and 5-lb. maximum daily starter levels with 84 Holstein calves. The experimental animals were on trial from six or eight days after birth through 16 weeks of age. The efficacy of including a high level of alfalfa silage in the diet of the lighter breeds was studied with ten Guernsey male calves at a 3-lb. daily starter level.

Based on the data of the three experiments reported here, the following conclusions are indicated:

The ad libitum feeding of good quality alfalfa silage as the sole source of roughage to the young Holstein calf during the first 16 weeks of life resulted in growth response comparable to the feeding of either alfalfa hay or alfalfa hay and alfalfa silage fed in combination.

Growth performance and TDN consumption tended to parallel each other during the first 16 weeks of life, whether the roughage portion of the rations of Holstein calves was alfalfa hay alone or alfalfa hay and alfalfa silage fed free choice.

When good quality alfalfa silage was fed to young Holstein calves, relatively low dry matter and TDN consumption was noted.

Limiting Holstein calves to 3 lb. of starter daily on a high quality ad libitum roughage feeding regime resulted in growth similar to the Ragsdale standard.

The feeding of high quality alfalfa silage as the sole source of roughage to the Guernsey calf from one week through 16 weeks of age resulted in growth that was satisfactory and equal to that of the hay-fed controls.

The feeding of high quality alfalfa silage to Holstein and Guernsey calves from the early days of life did not result in digestive disturbances.

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ERRORS IN DRYING SILAGE AND FECES FOR PROTEIN AND ENERGY DETERMINATIONS. IMPROVED PROCEDURES[1]

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Nutrient losses during drying were less in silages which were preserved with molasses, sulfur dioxide, or sodium metabisulfite; whereas, those unpreserved lost considerable protein. *Editor.*

Livestock men, dairymen in particular, realize that one of the keys to profitable production is the maximum use of high-quality forage, harvested at the proper stage of maturity and stored so as to reduce as much as possible the nutrient losses which result from poor methods of handling and adverse curing weather. Because the making and feeding of silage, both corn and grass, appear to be a good solution to this problem, the nutritive evaluation of silages has become increasingly important in recent years.

The two principal criteria of the nutritive value of a silage are its digestible protein content and its digestible energy content. To arrive at these two values, one must determine the protein and the energy contents of both the silage fed and feces produced. Protein usually is determined on dried samples of silage, and feces by the Kjeldahl method, although a few workers have used fresh material. Gross energy generally is determined by burning dried silage or feces in a bomb calorimeter. This procedure has been improved upon *(1, 2, 3)* by passing the volatile gases from the drying silage through a tube furnace and collecting the products in an absorber train. Results were calculated as acetic acid, and the energy value of the silage was corrected accordingly. These methods are tedious, and subject to errors resulting from leakage in the system and to assumptions which have to be made.

The authors became concerned about possible errors in currently used methods during 1951, when it was found that both protein and energy of silages were less digestible than the protein and energy of hays made from the same field at the same time; but that dairy heifers fed the silages retained considerably more protein and energy in spite of this apparent lower digestible nutrient intake. This was supported further by the fact that heifers fed silage gained more in

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body weight than animals fed comparable hay, although the digestible nutrient intake appeared to be lower in the animals fed the silage.

The work reported here was carried out to determine the magnitude of losses of protein and energy resulting from the drying of the silages and feces for chemical analysis. An improved procedure for the determination of energy values on fresh materials is described.

EXPERIMENTAL PROCEDURE

Silage samples used in this experiment were from lots of silage used in digestion experiments, from preservation studies, and from nearby farms. The feces used were composite samples from digestion experiments in which a variety of rations were fed.

Fresh silage samples were mixed thoroughly and divided into two comparable lots. One lot was placed in a wire basket and dried in a convection oven at a temperature of about 65° C. The dried material was ground in a Wiley mill and analyzed for protein by the Kjeldahl method, and for gross energy by means of an adiabatic bomb calorimeter. The second lot was ground first in a power meat-grinder fitted with a plate containing 3/8-inch holes and then reground with a plate containing 3/16-inch holes. When the ground silage could not be analyzed immediately, it was sealed in air-tight containers and placed in a freezer and thawed out just before being analyzed. In a few cases, the ground sample was dried in a vacuum oven at 62° C. to determine the losses.

The composite feces samples were collected in 5 qt. air-tight glass jars and kept in a freezer. When the collection period was ended, the feces were thawed overnight and then thoroughly mixed. Part of the sample was then dried, ground, and analyzed in the same manner as the silage. The remainder was analyzed in the fresh state.

The fresh ground silage and the moist feces were analyzed in much the same manner. To determine protein, three covered glass moisture dishes were filled with the moist material and a single 3- to 5-g. sample was removed from each with a spatula and dropped into a Kjeldahl flask. A piece of filter paper was used to wipe the spatula clean and then dropped into the flask. Digestion and distillation were carried out in the usual manner. Weight of the sample was determined by difference. The moisture dishes were then dried to determine "apparent" moisture content. A comparable piece of filter paper was placed in the blank flask.

Gross energy was determined by weighing approximately 2 g. of fresh silage or fresh feces into the capsules just before the sample was to be burned. One ml. of 95% alcohol was pipetted into the capsule just before the bomb was sealed. Combustion was then carried out in the usual manner. Alcohol used in this experiment had a gross energy value of 4.9826 Calories per milliliter. This value was subtracted from the total gross energy value to get the gross energy value of the silage or feces. Alcohol priming eliminates the need for drying and the col-

TABLE 1 (Continued)

Losses of protein and energy from silage due to drying

Kind of silage	Preservative	Quality	"Apparent" moisture content	Protein content (fresh basis)			Energy content (fresh basis)		
				Fresh	Dried	Loss	Fresh	Air-dried	Loss
			(%)				*(Cal/g)*	*(Cal/g)*	(%)
Oats	Molasses	Good	76.4				1.16	1.05	9.5
Timothy	SO_2	Good	64.7				1.80	1.57	12.8
Timothy	Molasses	Good	65.3				1.76	1.54	12.5
Grass–legume	SO_2	Good	62.9				1.89	1.64	13.2
Grass–legume	SO_2	Good	77.2				1.15	1.02	11.3
Grass–legume	SO_2	Good	80.7	2.23	2.16	3.1			
Grass–legume	SO_2	Good	84.7	2.04	1.99	2.5			
Grass–legume	SO_2	Good	84.0	2.09	2.20	− 5.3			
Grass–legume	SO_2	Good	82.9	1.91	1.78	6.8			
Grass–legume	SO_2	Good	83.4	1.64	1.59	3.0			
Grass–legume	SO_2	Good	83.3	2.09	2.13	− 1.9			
Grass–legume	SO_2	Fair	82.6	2.09	1.98	5.3	0.85	0.77	9.4
Grass–legume	SO_2	Poor	85.5	1.58	1.46	7.6			
Grass–legume	$Na_2S_2O_7$	Excellent	69.8	5.91	6.05	− 2.3			
Grass–legume	$Na_2S_2O_7$	Excellent	72.0	5.36	5.57	− 3.9			
Grass–legume	$Na_2S_2O_7$	Excellent	71.3	3.33	3.20	3.9	1.44	1.21	16.0
Grass–legume	$Na_2S_2O_7$	Excellent	70.8	5.09	5.03	1.2			
Grass–legume	$Na_2S_2O_7$	Excellent	74.6	4.25	4.17	1.9			
Grass–legume	$Na_2S_2O_7$	Excellent	70.7	5.03	4.94	1.8			
Grass–legume	$Na_2S_2O_7$	Very good	70.9	5.67	5.63	0.7			
Grass–legume	$Na_2S_2O_7$	Good	72.6				1.33	1.22	8.3
Grass–legume	Molasses	Excellent	73.9	3.73	3.76	− 0.8			
Grass–legume	Molasses	Excellent	72.7	3.74	3.88	− 3.7			
Grass–legume	Molasses	Excellent	71.8	3.92	3.77	3.8			
Grass–legume	Molasses	Excellent	73.8	3.98	4.01	− 0.8			
Grass–legume	Molasses	Excellent	73.6	4.04	3.93	2.7			
Grass–legume	Molasses	Excellent	75.1	3.97	3.84	3.3			

TABLE 1 (Concluded)

Losses of protein and energy from silage due to drying

Kind of silage	Preservative	Quality	"Apparent" moisture content	Protein content (fresh basis)			Energy content (fresh basis)		
				Fresh	Dried	Loss	Fresh	Air-dried	Loss
			(%)				*(Cal/g)*	*(Cal/g)*	(%)
Grass–legume	Molasses	Very good	70.0	3.63	3.53	2.8			
Grass–legume	Molasses	Very good	72.1	3.54	3.31	6.5			
Grass–legume	Molasses	Very good	72.4	3.51	3.35	4.6			
Grass–legume	Molasses	Good	60.3				2.01	1.76	12.4
Grass–legume	Molasses	Fair	72.6	3.89	2.98	23.4	1.34	1.20	10.4
Grass–legume	None	Good	81.5	2.41	2.06	14.5			
Grass–legume	None	Good	82.3	2.19	1.88	14.2			
Grass–legume	None	Good	82.3	2.88	2.42	16.0			
Grass–legume	None	Fairly good	81.2	2.60	2.16	16.9			
Grass–legume	None	Fairly good	82.8	1.95	1.67	14.4			
Grass–legume	None	Fairly good	82.3	2.71	2.56	5.5			
Grass–legume	None	Fairly good	80.5	3.04	2.52	17.1			
Grass–legume	None	Fair	82.6	2.32	1.97	15.1			
Grass–legume	None	Fair	85.1	3.36	2.20	34.5			
Grass–legume	None	Fair	81.9	3.18	2.63	17.3			
Grass–legume	None	Fair	83.6	1.93	1.66	14.0			
Grass–legume	None	Fair	75.3	2.59	1.63	37.1	1.22	1.09	10.7
Grass–legume	None	Fair	77.3	2.06	1.31	36.4	1.19	0.96	19.3
Grass–legume	None	Fair	82.9	2.32	1.72	25.9	0.90	0.80	11.1
Corn	None	Good	75.2	2.02	1.91	5.4	1.17	1.05	10.3
Corn	None	Good	74.3	2.30	2.25	2.2	1.25	1.09	12.8
Corn	None	Good	73.7	2.31	2.21	4.3	1.25	1.11	11.2
Corn	None	Good	80.3	1.56	1.49	4.5	0.95	0.82	13.7
Corn	None	Good	73.7	2.34	2.22	5.1	1.27	1.10	13.4
Corn	None	Good	81.1	1.60	1.43	10.6	0.95	0.80	15.8
Corn	None	Good	77.6	1.95	1.87	4.1	1.19	0.94	21.0

TABLE 2

Comparison of methods of drying silage as applied to protein and energy losses

Kind	Preservative	"Apparent" moisture content	Quality	Protein loss		Energy loss	
				Convection oven	Vacuum oven	Convection oven	Vacuum oven
				(%)			
Corn	None	77.6	Good	4.1	5.6	20.5	19.4
Grass–legume	None	77.3	Fair	36.4	36.9	19.3	14.9
Grass–legume	$Na_2S_2O_7$	71.3	Excellent	3.9	3.8	16.2	14.5
Grass–legume	None	75.3	Fair	37.1	34.3	10.7	10.9

lection of volatile materials lost in drying, and results in complete combustion *(1, 2, 3)*.

Protein and energy values in all cases were calculated on the fresh basis, so that they would be comparable.

RESULTS AND DISCUSSION

Table 1 shows the analyses of 53 different samples both in the fresh state and after drying in a convection oven. In 46 of these samples the loss of protein due to drying was determined. The crude protein losses (as seen in Table 3) in the corn and grass-legume silages without preservative were highly significant statistically. In the silages preserved with sulfur dioxide or sodium metabisulfite, however, the losses were not statistically significant. There was not a significant difference in the loss of the protein when the silages were dried in a vacuum oven as compared to those that were dried in a convection oven (Table 2).

The energy content, both in the fresh state and after drying, was determined with a bomb calorimeter in 20 of the 53 silage samples. In all kinds of silages, regardless of method of preservation, losses of energy due to drying were significant (Table 3). As with protein, the loss of energy was not significantly different when the silages were dried in a vacuum oven as compared to the convection oven (Table 2).

TABLE 3

Summary of protein and energy losses due to drying

Kind of silage	Preservative	Protein			Energy		
		Mean	Range	Significance	Mean	Range	Significance
		(%)					
Corn	None	5.2	2.2 to 10.6	1	14.0	10.6 to 19.4	1
Grass–legume	SO_2, $Na_2S_2O_7$	1.6	−5.9 to 7.6	Not significant	12.0	8.0 to 16.2	1
Grass–legume	Molasses	4.1	−4.3 to 23.7	Not significant	10.7	10.1 to 13.3	1
Grass–legume	None	20.3	5.5 to 37.1	1	13.8	10.9 to 19.3	5

TABLE 4

Losses of protein and energy from feces due to drying

Ration fed	"Apparent" moisture content	Protein content (fresh basis)			Energy content (fresh basis)		
		Fresh	Dried	Loss[a]	Fresh	Dried	Loss[a]
	(%)				*(Cal/g)*	*(Cal/g)*	(%)
Hay and crimped oats	77.38	2.56	2.07	19.1	1.15	1.05	8.7
Hay and crimped oats	77.09	2.39	1.93	19.2	1.13	1.08	4.4
Hay and ground oats	74.73	2.25	2.07	8.0	1.22	1.17	4.1
Hay and ground oats	76.05	2.54	2.01	20.9	1.35	1.09	19.3
Hay and ground oats	76.23	2.45	2.09	14.7	1.29	1.10	14.7
Hay and crimped oats	77.83	2.53	2.05	19.0	1.15	1.02	11.3
Hay and flaked corn	77.94	2.78	2.85	−2.5	1.15	1.04	9.6
Hay and flaked corn	76.83	3.01	2.92	3.0	1.28	1.11	13.3
Hay and flaked corn	80.71	2.58	2.48	3.9	1.15	0.91	20.9
Hay and flaked corn	77.37	3.01	2.78	7.6	1.19	1.04	12.6
Hay and ground oats	76.65	2.14	1.96	8.4	1.36	1.08	20.6
Hay and ground oats	76.55	2.08	1.85	11.1	1.36	1.08	20.6
Hay and crimped oats	78.66	2.03	1.86	8.4	1.13	0.98	13.3
Hay and crimped oats	78.15	2.33	2.28	2.1	1.18	1.01	14.4
Hay and crimped oats	79.15	2.22	1.94	12.6	1.12	0.97	13.4
Hay and ground oats	76.07	2.18	1.98	9.2	1.30	1.11	14.6
Hay and ground oats	76.04	2.43	2.27	6.6	1.33	1.11	16.5
Hay	75.45	2.53	2.20	13.0	1.33	1.16	12.8
Hay	77.64	2.49	1.70	31.7	1.23	1.03	16.3
Hay	77.54	2.60	1.71	34.2	1.26	1.06	15.9
Hay	77.03	1.99	1.99	0	1.25	1.10	12.0
Mean		2.43	2.14	11.9	1.23	1.06	13.8

[a] Both protein and energy losses due to drying are significant to 1% level.

Table 4 shows the protein and energy content of 21 samples of feces analyzed in both the fresh and dried state. Protein losses ranged from − 2.5 to 34.2% and energy losses ranged from 4.1 to 21.0%. Both protein and energy losses due to drying were significant at the 1% level.

In all the materials studied, the losses of energy covered a wide range. Losses of protein in the silages made without preservative and the feces varied considerably also. These wide ranges in both protein and energy losses indicate that a satisfactory correction factor is not possible, and that protein and energy determinations on silages and feces should be made on fresh material.

SUMMARY AND CONCLUSION

Fifty-three silage samples and 21 samples of feces were used in a study to determine the loss of protein and energy due to drying.

Silages preserved with molasses, sulfur dioxide, or sodium metabisulfite were more stable during drying, in that they retained their crude protein content much better than corn or unpreserved grass-legume silages. The latter silages lost an appreciable part of their protein content when dried for analysis. These results suggest that the loss of crude protein on drying might be used as a measure of the effectiveness of a silage preservative.

There were highly significant losses of energy from all silage samples when dried, regardless of preservative used. Feces also showed a highly significant loss of energy when dried.

The use of alcohol as a primer in determining the caloric value of fresh silages and moist feces eliminates the drying process and the resulting loss of volatile materials. This makes the procedure simple, rapid, and accurate.

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THE CHARACTERIZATION OF SOME LACTOBACILLI FOUND IN MILK [1]

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Lactobacilli were found in many dairy products by using enrichment techniques. The best sources were ungraded raw milk, Grade A raw milk, and sour cream. Some of the cultures, in populations of 10^6 per milliliter, survived 61.8° C. for 30 minutes. *Editor.*

The occurrence of lactobacilli in milk has been reported by many investigators *(2, 5, 8, 9, 10, 18, 19)*. Nevertheless, there is relatively little information available as to the species present in various grades of milk and cream.

After a culture has been isolated from milk or other sources, identification has proved to be difficult largely because of the variability of many of the characteristics which serve as taxonomic criteria *(5)*. However, some recent papers *(3, 4, 11, 14, 15, 21, 24, 25)* have shown that these variations may be reduced by the use of nutritionally adequate media. Tittsler *et al. (21)*, Rogosa *et al. (15)*, Wheater *(24, 25)*, and Briggs *(4)* classified lactobacilli with media they believed to be nutritionally adequate, and their results are quite similar.

The purposes of this investigation were to isolate lactobacilli from different grades of milk and cream and to study their characteristics with the methods described by Tittsler *et al. (21)*,[3] Rogosa *et al. (15)*, and Briggs *(4)*. The valuable papers of Wheater *(24, 25)* and Sharpe *(16)* did not appear until after this work was completed, but it has been possible to apply Wheater's classifications to some of the cultures.

METHODS

Isolation of cultures. Four hundred six samples were collected, the majority obtained from within a 30-mile radius of Columbia, Missouri. The type and number of samples were as follows: Grade A raw — 196, ungraded raw — 29,

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[3] This paper is an abstract. A chart summarizing the results can be seen in the report of Rogosa *et al. (15)*. A description of the material and methods used by Tittsler *et al.* was obtained by correspondence.

ungraded pasteurized — 26, aseptically drawn — 61, sour cream — 31, Grade A pasteurized whole — 45, Grade A skim — 6, and Grade A cream — 12. The aseptically drawn samples were obtained by thoroughly washing the cow's udder and teats with warm water containing a detergent, wiping the teats and udders with a clean cloth saturated in 100 p.p.m. chlorine solution, milking several streams into a strip cup, and then taking the sample in a sterile tube.

Isolations were made from plates poured from enriched and nonenriched samples. Enrichments were prepared by filling a sterile screw-top test tube with a sample and incubating for 14 days at 37° C. A few tubes were incubated at 30° to 45° C. If Gram-positive rods were present in the tubes after incubation, the samples were diluted as outlined by the American Public Health Association *(1)*. V-8 juice *(20)* and Briggs' *(4)* media were used to plate the enrichments and Rogosa's medium *(12, 13)* for the nonenriched and sour cream samples. V-8 juice stained through two layers of cheesecloth was substituted for tomato juice in all media where the latter was designated. The plates were incubated for 5 to 7 days at 37° C.

Colonies were transferred into yeast-glucose-litmus milk containing 10% V-8 juice, which was incubated at 37° C. for 6 to 10 days. If no change occurred, the cultures were discarded. All yeast-glucose-litmus milk tubes showing acid production, reduction, and coagulation was examined for Gram-positive rods. These isolates were replated until pure cultures were obtained, and the colonial types were noted. Tests for catalase, nitrate reduction, gas production, and titratable acidity were performed on both the isolates and the known cultures listed in Table 1. Glucose-gas tubes *(6)* and screw-top tubes containing 9 ml. of sterile skimmilk were inoculated from the yeast-glucose-milk isolates with 1.0 and 0.1 ml., respectively, and incubated for 2 weeks at 37° C. to determine gas production and titratable acidity. The cultures selected for further study were all Gram-positive, nonsporeforming, non-nitrate reducing, catalase negative rods.

The known cultures and isolates were tested for:

a) their ability to ferment carbohydrates as described by Tittsler *(20)*
b) their ability to grow in the defined medium of Tittsler *(20)*
c) growth at 16, 45 and 48° C. in Briggs' medium *(3)*
d) survival at 60° C. for 90 minutes, 61.8° C. for 30 minutes, and 65° C. for 30 minutes in Briggs' medium using her procedures *(4)*
e) tolerance of 4% sodium chloride in Briggs' medium
f) hydrolysis of arginine in Briggs' medium

All of these media were inoculated with a double loop from an active culture.

RESULTS AND DISCUSSION

Known cultures. The characteristics of the known cultures listed in Table 1, except B-1, agreed with the descriptions and classification schemes suggested by Tittsler *et al. (21)* and Rogosa *et al. (15)*. B-1, a commercial acidophilus culture, which had been in the authors' collection for several years, was identified as

TABLE 1

Sources, code numbers, and names of cultures before classification

Code No.	Names	Source
B1	*L. acidophilus*	Univ. of Missouri
B5	*L. acidophilus*	USDA V200
B14	*L. acidophilus*	USDA V203
B15	*L. acidophilus*	USDA V204
B16	*L. acidophilus*	USDA V205
B32	*L. acidophilus*	USDA V206
B4	*L. bulgaricus*	Iowa State College
B17	*L. bulgaricus*	USDA V2
B18	*L. bulgaricus*	USDA V4
B19	*L. bulgaricus*	USDA V10
B20	*L. bulgaricus*	USDA V12
B22	*L. bulgaricus*	USDA V29
B23	*L. bulgaricus*	USDA V71
B25	*L. bulgaricus*	USDA V81
B6	*L. casei*	ATCC 334
B7	*L. casei*	Univ. of Missouri
B8	*L. casei*	Iowa State College
B9	*L. casei*	ATCC 7469
B27	*L. casei*	ATCC 393
B28	*L. casei*	ATCC 4007
B29	*L delbrueckii*	ATCC 9649
B10	*L. fermenti*	ATCC 9338
B30	*L. lactis*	ATCC 8000
B12	*L. leichmannii*	ATCC 4797
B13	*L. plantarum*	Iowa State College
B11	*L. plantarum*	ATCC 8014
B31	*L. plantarum*	ATCC 8041
B33	*L. plantarum*	USDA V322
B34	*L. plantarum*	USDA V323
B35	*L. plantarum*	USDA V331
B36	*L. plantarum*	USDA V743
B37	*L. plantarum*	USDA V771

L. lactis. In general, the cultures also conformed to the classifications reported by Wheater *(24, 25)*. One culture of *L casei*, B-9, was identified as *L. casei* var. *rhamnosus* by the classification of Rogosa *et al. (15)* and as *L. helveticus* by Wheater's scheme *(25)*. Wheater suggested that these two strains are identical and these results support her suggestion.

TABLE 2

Lactobacilli surviving pasteurization at 61.8° C. for 30 minutes

Species	Known cultures		Isolated cultures	
	Total No.	No. Surviving	Total No.	No. Surviving
L. acidophilus	5	2	7	0
L. brevis	—	—	3	0
L. bulgaricus	8	6	1	1
L. casei	6	4	51	16
L. delbrueckii	1	1	—	—
L. fermenti	1	0	8	1
L. lactis	2	2	2	2
L. leichmannii	1	1	—	—
L. plantarum	8	0	20	0
Unidentified	—	—	10	0
	32	16	102	20

Several of the known cultures survived pasteurization at 61.8° C. for 30 minutes. These and similar data for the isolates are presented in Table 2. Briggs *(1)* found that some cultures of *L. lactis*, *L. bulgaricus*, *L. leichmannii*, and *L. delbrueckii* survived 60° C. for 90 minutes. The data in Table 2 indicate that most of these cultures were thermoduric. In evaluating this data, it should be remembered that the pasteurization efficiency was probably high. The tubes of Briggs' medium subjected to the pasteurization temperature contained approximately 10,000,000 organisms per milliliter. After pasteurization the tubes were incubated and checked for growth. In normal milk it is not likely that the lactobacilli would be present in such relatively large numbers.

Isolated cultures. Eight hundred sixty-seven cultures were isolated from 95 samples. Many isolates from some samples were identical. After duplicates were discarded, 102 cultures remained for study. The classifications of these cultures are listed in Table 3. With a few exceptions their characteristics were similar to

TABLE 3
Classification of lactobacilli isolated from milk and cream

Species[a]	No. of strains	Per cent
L. acidophilus	7	6.9
L. bulgaricus	1	1.0
L. casei[b]	51	50.0
L. lactis	2	2.0
L. plantarum	20	19.6
Homofermentative unidentified	2	2.0
L. brevis	3	2.9
L. fermenti	8	7.8
Heterofermentative unidentified	8	7.9
	102	100

[a] Species names are based on the descriptions given by Tittsler *et al. (21)* and Rogosa *et al. (15)*.
[b] Seven of these cultures may be called *L. helveticus*, according to Wheater *(25)*.

those of the known cultures. Ten isolates could not be identified by name. The characteristics of these unidentified cultures were not so unique as to suggest new species. Instead, growth failures or contaminations were suspected. However, the characteristics did not change after purification and retesting.

Reference to Table 3 shows that only a few cultures of *L. acidophilus*, *L. lactis*, and *L. bulgaricus* were isolated. This was not unexpected, because Sherman and Stark *(18)* found that *L. casei* was present in milk in much higher numbers than either *L. acidophilus* or *L. bulgaricus*. Freshly isolated cultures of *L. bulgaricus* were reported by Sherman and Hodge *(17)* to grow vigorously at 55° C. and to require anaerobic conditions. As the enrichment incubation temperature used in the present study was 37° C. and no special anaerobic conditions were used, conditions were probably not optimum for the isolation of *L. bulgaricus*. Tittsler *et al. (21)* noted that cultures of *L. delbrueckii* and *L. leichmannii* did not

ferment lactose. Since the enrichments were made in milk, the inability of these species to ferment lactose may explain why none were isolated.

None of the known or isolated cultures of *L. acidophilus*, *L. bulgaricus*, or *L. lactis* grew in Briggs' 4% NaCl medium. This lack of salt tolerance probably explains why Tittsler *et al. (22, 23)* could not find added cultures of these three species in Cheddar cheese after 2 weeks.

Results from the pasteurization resistance tests on the isolates are presented in Table 2. Twenty of the isolates survived pasteurization, but only three of these, two of *L. lactis* and one of *L. casei*, were isolated from pasteurized products.

Sources of cultures. Lactobacilli were isolated from 96 of the 406 samples. The distribution of the lactobacilli in the various samples is shown in Table 4.

TABLE 4

Distribution of lactobacilli according to type of sample

Species	Grade A				Ungraded				
	Pasteurized			Raw	Raw	Pasteurized	Sour cream	Aseptically drawn	Totals
	Whole	Skim	Cream						
L. acidophilus	—	—	—	7	—	—	—	—	7
L. bulgaricus	—	—	—	1	—	—	—	—	1
L. casei	—	—	1	36	7	3	4	—	51
L. lactis	2	—	—	—	—	—	—	—	2
L. plantarum	1	1	1	9	2	—	4	2	20
Unidentified homofermenters	1	—	—	1	—	—	—	—	2
L. brevis	—	—	—	2	—	—	1	—	3
L. fermenti	—	—	—	2	6	—	—	—	8
Unidentified heterofermenters	—	—	1	6	—	—	1	—	8
Number of samples containing lactobacilli	4	1	3	64[a] 60	15	3	10[b] 8	2	96
Total number of samples	45	6	12	196	29	26	31	61	406
Proportion of samples which contained lactobacilli (%)	8.9	16.7	25.0	30.3	44.8	11.5	25.8	3.2	—

[a] Two cultures were isolated from each of four samples.
[b] Two cultures were isolated from each of two samples.

Inspection of Table 4 reveals that *L. plantarum* and *L. casei* were the most widely distributed species. Ungraded raw, Grade A raw, and sour cream were the best sources of lactobacilli. In six samples two different cultures of different characteristics were isolated from each. These samples yielded combinations of *L. casei* with *L. acidophilus*, *L. brevis* or *L. fermenti* and *L. plantarum* with an unidentified heterofermenter. Two cultures of *L. plantarum* were found in the aseptically drawn samples, but these were believed to be contaminants from feed, dust, etc. Hammer *(7)* stated that milk never contained lactobacilli at the start of milking but they were always found before milking was completed. Obviously the udder did not contain lactobacilli, and their presence in aseptically drawn milk must be attributed to contamination. It seems apparent that the lactobacilli

are widely distributed in dairy products, even in Grade A and pasteurized milks, and can be readily isolated with enrichment techniques.

SUMMARY

One hundred two lactobacilli isolated from 406 samples of milk and cream and 32 known lactobacilli were studied by the methods of Tittsler *et al. (21)*, Rogosa *et al. (15)*, and Briggs *(4)*. The isolation techniques are described. Ninety-two (90.1%) of the isolated cultures were named.

L. casei comprised 50.0% of the 102 isolates: *L. plantarum*, 19.6; unidentified heterofermenters, 7.9; *L. fermenti*, 7.8; *L. acidophilus*, 6.9; *L. brevis*, 2.9; *L. lactis*, 2.0; unidentified homofermenters, 2.0; and *L. bulgaricus*, 1.0. *L. plantarum* was the most widely distributed of the species.

The best sources of lactobacilli in this study were ungraded raw milk, Grade A raw milk, and sour cream. Data concerning resistance to 61.8° C. for 30 minutes are presented for all the cultures.

ACKNOWLEDGMENT

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THE OXIDATION OF VANILLIN BY UNHEATED MILK [1]

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Xanthine oxidase in raw milk oxidizes vanillin to vanillic acid which reacts with 2,6-dibromoquinonechloroimide. This reaction seems suitable for measuring the enzyme's activity and for evaluating the heat treatment of high heat nonfat dry milk. *Editor.*

Edwards *(3)* observed that when unheated whole milk is incubated with vanillin a blue color develops upon subsequent addition of 2,6-dibromoquinonechloroimide (BQC). This phenomenon was first observed in false positive phosphatase tests of vanilla ice cream mix. Color development decreased with heat treatment; milk heated to 80° C. produced no color. Vanillin alone did not develop a blue color with BQC; however, vanillyl alcohol produced a blue color directly upon addition of BQC. Other compounds related to vanillin in structure, namely benzaldehyde, p-hydroxybenzaldehyde, and anisaldehyde did not produce a color when substituted for vanillin. Vanillic acid was not tested by Edwards. The activating agent, undoubtedly an enzyme, was not identified. Attempts were made to substitute potato peroxidase and liver catalase as the enzyme source in the test. No catalytic effect was found to occur when these enzymes were substituted for milk.

The enzyme xanthine oxidase is known to oxidize vanillin (1), either methylene blue or oxygen serving as hydrogen acceptor. If this enzyme is responsible for the phenomenon described by Edwards *(3)*, the reaction should be inhibited by exclusion of oxygen, vanillic acid should give the test, and addition of purified xanthine oxidase to heated milk should restore its ability to develop the test.

This study was initiated to describe and study the reaction between milk and vanillin, the subsequent color development with BQC, and the relation of this reaction to xanthine oxidase activity.

METHODS AND MATERIALS

Determination of vanillin oxidizing activity. The method used was that outlined by Edwards *(3)* and is as follows: To 0.5 ml. of milk in a 50-ml. centrifuge tube add 1 ml. of aqueous vanillin solution (1 mg./ml.). After incubating the tubes at 60° C. for 5 minutes, add 5 ml. of borate buffer (pH 9.2). After mixing, add 0.25 ml. of a 0.4% ethanolic BQC solution and shake the tubes thoroughly. Allow fifteen minutes for color development and extract the resulting

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blue color with 20 ml. of 1-butanol by first shaking vigorously and then centrifuging. Measure the absorbance of the blue butanol solution at 650 mμ using a blank prepared in the same manner from a sample of milk which has been boiled for 30 minutes.

Determination of xanthine oxidase activity. To 5 ml. of milk in a Thunberg tube add 0.2 ml. of 0.0113 M methylene blue solution. After placing 1 ml. of aqueous xanthine solution (1 mg./ml.) in the side arm, evacuate the tube and temper to 50° C. Then tip the tube and measure the xanthine oxidase activity by the time in seconds required to reduce the methylene blue to the colorless leuco form. Duplicates were run for each sample and the reciprocal of the time in seconds taken as a measure of xanthine oxidase activity.

Reagents. Chemical reagents were secured from commercial sources except vanillic acid which was synthesized from vanillin by the silver oxide method *(8)*. Xanthine oxidase was obtained in the form of a commercially available concentrate (Nutritional Biochemicals Co.).

RESULTS

Originally, Edwards' method was studied as a possible means of assessing the heat treatment of milk, since the time and temperature to inactivate the enzyme closely parallel the requirements for the manufacture of low heat nonfat dry milk. For this reason, a survey was made of a number of milk samples obtained from individual cows and commercial sources. These milks were separated and activities of the whole milk and skimmilk were compared. Table 1 shows that

TABLE 1
The variation in vanillin oxidizing activity (absorbance) of whole milk and separated skimmilk

Milk Sample	Absorbance at 650 mμ	
	whole milk	skim
1	1.120	0.538
2	0.850	0.439
3	1.080	0.690
4	0.840	0.423
5	1.140	0.256

a great deal of the activity follows the cream upon separation and thus must be closely associated with the fat or the fat globule "membrane." The value of this method for assessment of low heat nonfat dry milk of unknown origin would depend on a constant absorbance obtained from the original skimmilk. The variation in activities exhibited by the skimmilks tested rather precludes its use for this purpose.

An attempt was next made to ascertain whether xanthine oxidase is the causative agent in this test. Performing the test at a reduced oxygen tension by evacuating and replacing the air with nitrogen showed that the reaction involving vanillin and milk depends on the presence of oxygen. Two samples of milk were tested in this way and the data are shown in Table 2.

TABLE 2
The influence of nitrogen on the vanillin oxidizing activity of milk

Sample	Absorbance at 650 mμ	
	air	nitrogen
1	0.670	0.130
2	0.804	0.189

In order to establish that the oxidation product of vanillin, vanillic acid, can produce the color, the latter was substituted as the substrate in the Edwards procedure. The resulting color with BQC was compared to that obtained from vanillin, milk and BQC. Figure 1 illustrates that the blue color formed from vanillic acid and BQC was identical to the color formed in the Edwards procedure when compared spectrophotometrically. While equimolar concentrations of vanillin and vanillic acid were used in this comparison, the greater absorbance developed with vanillic acid may be due to incomplete oxidation of vanillin under conditions of the method.

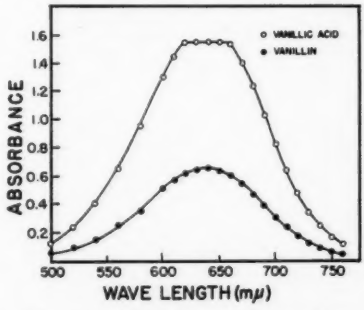

FIG. 1. Absorbancy curves of blue color formed from:
(1) 1 ml. 0.006 M vanillin + 0.5 ml. milk + BQC
(2) 1 ml. 0.006 M vanillic acid + 0.5 ml. milk + BQC

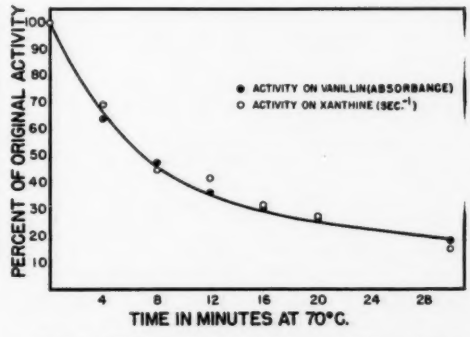

FIG. 2. The inactivation of the vanillin and xanthine oxidizing activities of milk by heating at 70° C.

Further confirmation that xanthine oxidase is responsible for this phenomenon was obtained by comparing the loss of vanillin oxidizing activity and xanthine oxidase activity when a sample of milk was heated for various periods of time at 70° C. As shown in figure 2, the two activities are lost at the same rate.

Xanthine oxidase is further implicated by the finding that addition of a commercial concentrate of this enzyme to heated skimmilk restored the vanillin oxidizing ability (table 3). Thus there seems to be little doubt that the oxidation of vanillin by raw milk is a manifestation of the activity of xanthine oxidase.

Since BQC is supposedly specific for p-unsubstituted phenols *(2, 4, 5, 6, 7)*, yet reacts with vanillyl alcohol and vanillic acid, a quantitative study was made

of its reactivity with the fifteen different phenols listed in table 4. In each case 1 ml. of 0.006 M solution was used (equivalent to 1 mgm. vanillin per ml.). Color development in aqueous solution and after incubation with raw skimmilk and heated skimmilk was measured. Furthermore since previous workers *(2, 4)* had used 2,6-dichloroquinonechloroimide (CQC) instead of BQC, the color development of these phenols with CQC in aqueous solution was determined. The results are not in agreement with previous work and with the generalization that p-substituted phenols do not react, since vanillyl alcohol, vanillic acid, and p-hydroxybenzoic acid give the color. The presence of milk, either raw or heated, depressed the color development in a number of cases, notably o-hydroxybenzylalcohol and p- and m-hydroxybenzoic acids.

TABLE 3

Vanillin oxidation by xanthine oxidase concentrate added to heated skimmilk

Amount xanthine oxidase concentrate added to heated skim[a]	Skim Sample 1	Skim Sample 2
ml./100 ml.	*Absorbance*	*Absorbance*
0	0 (blank)	0 (blank)
1	.22	.30
2	....	.41
4	....	.45
8	....	.53
Raw Skim	.49	.47

[a] Heated in boiling water bath 30 min.

TABLE 4

Color development of various phenols with 2,6-dibromoquinonechloroimide and 2,6-dichloroquinonechloroimide

Phenol [a]	Reaction with BQC		Reaction with CQC in H_2O
	Incubated with	In H_2O	
	Raw Milk / Heated Milk		
	Absorbance		
Vanillyl alcohol	1.7 / 1.9	1.7	2
Vanillin	.41 / 0 (blank)	0 (blank)	0 (blank)
Vanillic acid	1.0 / 1.4	1.5	2
3-ethoxy-4-hydroxybenzaldehyde	.57 / 0	0	.01
o-hydroxybenzylalcohol	.64 / .88	1.4	2
Salicylaldehyde	.01 / .03	.11	.04
Salicylic acid	0 / 0	0	0
p-hydroxybenzaldehyde	.02 / 0	0	0
p-hydroxybenzoic acid	.25 / .28	.89	1.70
m-hydroxybenzaldehyde	.12 / .02	.13	.15
m-hydroxybenzoic acid	.68[b] / .61[b]	.97[b]	1.03[b]
Catechol	.04 / .06	.06	0
Hydroquinone	.10 / .07	0	.05
Guiacol	1.8 / 1.9	1.7	2
Phenol	1.5 / 1.7	1.6	2

[a] 1 ml. 0.006 M solution of the phenol used in each case in the same technique as the Edwards' method.

[b] Blue color also in aqueous layer.

DISCUSSION

The results indicate that the reaction reported by Edwards involves oxidation of vanillin to vanillic acid by means of xanthine oxidase. It depends on the peculiar combination of circumstances that vanillin, which does not react with BQC, is oxidized to vanillic acid which does react. Of the various phenols tested, only vanillin and its ethyl homolog possess this combination. Although xanthine oxidase oxidizes such other phenolic aldehydes as salicylaldehyde, p-hydroxybenzaldehyde and m-hydroxybenzaldehyde *(1)*, the products either do not react with BQC, or the reaction is suppressed in the presence of milk (table 4).

These reactions appear suitable as a means for determining xanthine oxidase activity in milk. The procedure is simple and rapid and does not require the removal of oxygen. The color formed is very stable.

This method would not be suitable for assessing the maximum heat treatment that has been applied to a lot of low heat nonfat dry milk because the activity varies so much in raw skimmilk. However, the absence of vanillin oxidizing activity may be useful as a criterion for the adequacy of heating of high heat nonfat dry milk intended for baking purposes.

SUMMARY

The action of raw milk on vanillin which renders it reactive with 2,6-dibromoquinonechloroimide appears to be due to oxidation of vanillin to vanillic acid by xanthine oxidase. This reaction seems suitable as a method for determining xanthine oxidase activity and for assessing heat treatment of high heat nonfat dry milk.

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THE USE OF SYNTHETIC β-CAROTENE FOR COLORING BUTTER[1]

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Coal-tar derivatives for coloring butter have been prohibited in Germany and their prohibition has been recommended in England. The Food and Drug Administration in this country is re-examining the toxicity of these dyes. Synthetic β-carotene was used in this study to standardize the color of butter which did not change in color during storage. The vitamin A potency of the butter was increased 3800 I.U. per lb. *Editor.*

For several years the color of American and Canadian butter has been standardized almost exclusively with the coal-tar dyes Yellow AB and Yellow OB. Although Badger *et al. (7)* reported in 1942 that these dyes produced no tumors in rats at the site of application, various reports *(1, 3, 9, 29)* have since indicated that they may have some toxic or carcinogenic properties. Germany has prohibited their use in butter for several years. More recently, a British committee on food colors has recommended their prohibition (3). It is understood that the American and Canadian food and drug administrations are re-examining the toxicity of these dyes. In 1955, the U. S. Food, Drug and Cosmetic Act *(4)* was amended to delete from the list of permitted food colors FD & C Orange No. 1, FD & C Orange No. 2, and FD & C Red No. 32. In view of the published evidence it is presumed that Yellow AB and Yellow OB will also be prohibited in foods before long.

In view of these developments the Dairy Technology Research Laboratory in Ottawa has undertaken to examine the feasibility of using other coloring agents for butter.

The coloring of butter with natural carotene extracts has been studied by various investigators *(8, 19, 20, 22, 23, 24, 27, 28)* with discrepant results. In summary it appears that highly refined natural carotene extracts exert no deleterious effects on the quality of stored butter.

The commercial production of synthetic β-carotene, announced in 1953-54 by Hoffmann-La Roche *(26)*, induced us to investigate the feasibility of using this product to standardize the color of Canadian butter. Its use in butter is being recommended by the Vitamin Division of Hoffman-La Roche *(2)*. While this work was in progress, favorable reports on its use in butter have appeared from Austria *(6)* and The Netherlands *(19)*.

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EXPERIMENTAL AND METHODS

Manufacturing. The experiments were initiated in May, 1955, before the cows went on pasture. Twelve churnings of butter were made with carotene color and 12 churnings with coal-tar color, using split vats of First Grade and Second Grade cream *(5)*. The First Grade cream was obtained from the Experimental Farm Dairy. Its initial acidity ranged from 0.12 to 0.27% with a mean of 0.18%. The Second Grade cream obtained from a local milk plant ranged from a stale cream with 0.27% initial acidity to a sour cream of 0.48% initial acidity. Its mean acidity was 0.36%. In each vat the acidity was standardized to 0.10% acidity with soda neutralizers. The cream was pasteurized in coil vats of 500-lb. capacity at 170° F. for 10 min., cooled to and maintained at 40° F. overnight. Each vat of cream was split into four churnings which received the following treatments: (a) carotene color; (b) carotene color + 3 p.p.m. copper; (c) coal-tar color; and (d) coal-tar color + 3 p.p.m. copper.

The amount of synthetic β-carotene[2] required was predetermined initially according to Richardson's *(21)* method. It was added to the cream in the churn at the rate of 350 mg. per 100 lb. of fat as a 0.5% paraffin oil suspension. The coal-tar color (Hansen) was added at the rate of 1 oz. per 100 lb. of fat. The copper was also added to the cream in the churn as a 0.5% solution of copper sulfate, at the rate of 3 p.p.m. of the cream. The cream containing 32% fat was churned at 40° F. The butter was salted at 2.0%.

Four 1-lb. prints and two 7-lb. blocks of butter from each churning were wrapped in parchment paper, boxed and stored. Different samples from each churning were examined initially, after two weeks at 50° F., after six months at –5° F., and after six months at –5° F. plus two weeks at 50° F.

Methods of analysis. The samples were scored for flavor and evaluated for color with a Hansen color chart by three official graders. Each set of four comparable butters was ranked for flavor from 1 to 4 in order of preference by a taste panel of some 15 people.

For peroxide, aldehyde, acid degree and color values, butter oil was prepared just prior to analysis by melting and filtering the butter at 122° F. Peroxide values were determined by the method of Lips *et al. (16)*. Schibsted's method *(25)* as modified by Mummery *(18)* and Dolby *(10)* was used for fat aldehyde values. These latter were expressed in terms of density value × 100, at 510 mμ using a 1-cm. cell and a 5% fat solution. The fat acid degrees were expressed in ml. of 0.0500 *N* sodium ethylate per 5 g. of fat. They were determined by titrating 5 g. of the butter oil in 50 ml. of 1:1 benzene-ethanol to the phenolphthalein end-point with 0.0040 *N* sodium ethylate. The colors of the butter oils were determined by measuring the optical density at 450 mμ of a 20% solution of the oil in benzin. The color values were reported as γ β-carotene per g. of fat, $E^{1\ \gamma/\text{ml.}}_{1\ \text{cm.}} = 0.270$.

[2] Synthetic β-carotene was a complimentary sample received from Hoffmann-LaRoche as a 24% micropulverized suspension in peanut oil.

The copper contents of the butter were determined by the method described by McDowell *(17)*. The method of Koehn and Sherman (*15*) as described by Jenness and Palmer *(13)* was used to determine the vitamin A potency of the butters.

RESULTS AND DISCUSSION

Churnings made from cream without added copper gave butter with an average copper content of 0.32 p.p.m. This was increased to 1.45 p.p.m. where 3 p.p.m. of copper were added to the cream.

Color. Synthetic β-carotene at the rate of 0.35 g. per 100 lb. of fat produced a slightly deeper color than coal-tar color at the rate of 1 oz. per 100 lb. of fat. In terms of the Hansen color chart, butter colored with β-carotene was A_{3+} whereas butter colored with coal-tar was A_3. As shown in Table 1, the color

TABLE 1

Effect of type of color on color intensity of butter oil from stored butter

Treatment	No. of churnings	Storage				
		Initial	2 weeks 50° F.	6 months −5° F	6 months −5° F. + 2 weeks 50° F.	Mean
		(as γ β-carotene per g. fat)				
Carotene color:						
1st grade cream	6	10.4	10.9	10.8	10.4	10.6
2nd grade cream	6	11.0	10.4	11.6	11.0	11.0
Low copper	6	11.1	10.6	11.4	10.8	11.0
High copper	6	10.3	10.7	11.0	10.6	10.6
Coal-tar color:						
1st grade cream	6	8.6	8.2	8.3	9.7	8.7
2nd grade cream	6	8.8	8.6	9.0	8.8	8.8
Low copper	6	9.0	8.7	8.8	9.4	9.0
High copper	6	8.4	8.2	8.5	9.1	8.6
All carotene	12	10.6	10.7	11.2	10.7	10.8
All coal-tar	12	8.7	8.4	8.6	9.3	8.8
All samples	24	9.7	9.6	9.9	10.0	9.8

of the butter oil averaged 10.8 γ β-carotene per g. of fat for the butter colored with carotene and 8.8 for the butter colored with coal-tar. Under the conditions of this study the color of the butter was not affected by storage up to six months at –5° F. plus two weeks at 50° F.

Flavor. Table 2 shows that the type of color did not affect the flavor as scored by official graders. This was corroborated by a taste panel of some 15 people. The coefficients of concordance *(14)* given in Table 3 indicate that the panel members agreed that there was a difference between the treatments when the samples were stored six months at –5° F. plus two weeks at 50° F. The analysis of variance of the normal deviates *(12)* also indicated a difference between treatments, significant at $P = 0.01$. The multiple range test of Duncan *(11)* was used to determine which of the treatments were different. It was thus shown that the taste panel did not differentiate between the flavor of carotene

TABLE 2

Effect of type of color on the distribution of butters according to flavor score

Flavor[a] score	Storage							
	Initial		2 weeks 50° F.		6 months −5° F.		6 months −5° F. + 2 weeks 50° F.	
	Carotene	Coal-tar	Carotene	Coal-tar	Carotene	Coal-tar	Carotene	Coal-tar
	(No. samples)							
39.0	4	7	0	0	1	3	1	0
38.5	1	2	0	1	1	1	1	2
38.0	6	1	1	4	7	8	5	4
37.5	0	2	3	3	2	0	0	2
37.0	1	0	6	4	1	0	3	4
36.0	0	0	2	0	0	0	2	0
Chi-square	7.72		5.20		4.07		6.59	
Degrees of freedom	4		4		4		5	

[a] Official flavor score (Canada Dairy Products Act, Queen's Printer, Ottawa, 1955).

and coal-tar colored butters. A preference, however, was given to the butter with a low copper content for the storage treatments of six months at –5° F. and of six months at –5° F. plus two weeks at 50° F.

Chemical variables. The data in Table 4 indicate that the peroxide value was higher in the butter from first grade cream than in the butter from second grade cream. The peroxide value also increased with copper and storage treatments. The mean peroxide values for carotene and for coal-tar colored butters were identical. The variances for cream, for copper, and for storage were significant at $P = 0.01$, as shown in Table 8. The significant interactions of cream with copper and with storage indicate that the copper and the storage effects were greater in butter from first grade cream than in those from second grade cream.

TABLE 3

Effect of type of color on flavor ranking of stored butter

Storage	Av.[a] No. judgments	Treatment[b]				Concordance coefficient
		Carotene	Coal-tar	Carotene + copper	Coal-tar + copper	
		(Av.[a] sum of rankings)				
Initial	15.0	36.5	37.3	37.5	38.8	0.002
2 weeks 50° F.	13.5	36.7	30.7	34.2	33.5	0.020
6 months −5° F.	14.0	32.5	31.2	38.7	37.7	0.042
6 months −5° F. + 2 weeks 50° F.	11.5	22.8	22.7	36.3	33.2	0.225[c]

[a] Average of six replicates.

[b] The values under Treatment should not be construed for "flavor score." Each set of four comparable samples were ranked from 1 to 4 in order of preference. Therefore, these values are only horizontally comparable.

[c] Significant at $P = 0.05$.

TABLE 4

Effect of type of color on peroxide value of stored butter

Treatment	No. of churnings	Storage				
		Initial	2 weeks 50° F.	6 months −5° F.	6 months −5° F. + 2 weeks 50° F.	Mean
Carotene color:						
1st grade cream	6	0.31	0.48	0.90	1.64	0.83
2nd grade cream	6	0.43	0.58	0.92	0.75	0.67
Low copper	6	0.31	0.33	0.47	0.53	0.41
High copper	6	0.43	0.73	1.35	1.86	1.09
Coal-tar color:						
1st grade cream	6	0.55	0.74	0.84	1.52	0.91
2nd grade cream	6	0.41	0.51	0.77	0.67	0.59
Low copper	6	0.35	0.36	0.36	0.46	0.38
High copper	6	0.62	0.89	1.25	1.74	1.12
All carotene	12	0.37	0.53	0.91	1.20	0.75
All coal-tar	12	0.48	0.63	0.81	1.10	0.75
All samples	24	0.43	0.58	0.86	1.15	0.75

The aldehyde values given in Table 5 increased considerably with copper and with storage. Table 8 shows that the variances for copper and for storage were significant at $P = 0.01$. It is also indicated that the effect of storage was much less pronounced in the samples with lower copper content than in those

TABLE 5

Effect of type of color on aldehyde value of stored butter

Treatment	No. of churnings	Storage				
		Initial	2 weeks 50° F.	6 months −5° F.	6 months −5° F. + 2 weeks 50° F.	Mean
Carotene color:						
1st grade cream	6	6.14	9.34	15.30	33.58	16.09
2nd grade cream	6	4.65	8.51	14.35	40.44	16.99
Low copper	6	4.24	5.32	4.94	9.60	6.02
High copper	6	6.55	12.53	24.72	64.42	27.06
Coal-tar color:						
1st grade cream	6	7.91	12.04	18.34	42.57	24.23
2nd grade cream	6	7.08	9.21	12.80	39.14	17.06
Low copper	6	5.16	6.81	7.43	12.60	8.00
High copper	6	9.83	14.44	23.71	69.10	29.27
All carotene	12	5.40	8.92	14.83	37.01	16.54
All coal-tar	12	7.50	10.62	15.57	40.85	18.64
All samples	24	6.45	9.78	15.20	38.93	17.59

TABLE 6

Effect of type of color on acid degree of stored butter

Treatment	No. of churnings	Storage				
		Initial	2 weeks 50° F.	6 months −5° F.	6 months −5° F. + 2 weeks 50° F.	Mean
Carotene color:						
1st grade cream	6	0.99	1.03	1.02	0.95	1.00
2nd grade cream	6	1.28	1.19	1.16	1.16	1.15
Low copper	6	1.08	1.18	1.15	1.13	1.14
High copper	6	1.02	1.04	1.03	0.99	1.02
Coal-tar color:						
1st grade cream	6	1.06	1.11	0.97	0.97	1.03
2nd grade cream	6	1.08	1.14	1.10	1.08	1.10
Low copper	6	1.11	1.18	1.06	1.07	1.11
High copper	6	1.03	1.07	1.01	0.98	1.02
All carotene	12	1.05	1.11	1.09	1.06	1.08
All coal-tar	12	1.07	1.12	1.04	1.02	1.06
All samples	24	1.06	1.12	1.06	1.04	1.07

with higher copper content. The slightly lower aldehyde value in the butter colored with carotene as compared to coal-tar was not significant.

The data in Tables 6 and 8 show that neither the type of color, cream quality, copper level or storage caused any significant change in the acid degree of the butter.

TABLE 7

Effect of type of color on vitamin A potency of stored butter

Treatment	No. of churnings	Storage				
		Initial	2 weeks 50° F.	6 months −5° F.	6 months −5° F. + 2 weeks 50° F.	Mean
Carotene color:						
1st grade cream	6	12,700	13,500	13,300	12,700	13,000
2nd grade cream	6	12,600	12,600	13,700	12,900	13,000
Low copper	6	13,300	13,200	13,900	13,000	13,400
High copper	6	12,000	12,900	13,000	12,600	12,600
Coal-tar color:						
1st grade cream	6	9,800	9,500	10,600	8,900	9,700
2nd grade cream	6	7,800	8,900	8,900	9,300	8,700
Low copper	6	9,200	9,600	10,300	9,700	9,700
High copper	6	8,400	8,800	9,200	8,500	8,700
All carotene	12	12,700	13,100	13,500	12,800	13,000
All coal-tar	12	8,800	9,200	9,800	9,100	9,200
All samples	24	10,700	11,100	11,600	11,000	11,100

TABLE 8

Analysis of variance of peroxide, aldehyde, acid degree values, and of vitamin A potency

Source of variation	Degrees of freedom	Mean square			
		Peroxide value	Aldehyde value	Acid degree value	Vitamin A potency
Color	1	0.0000	88.84	0.0388	342.40[a]
Cream	1	1.3940[a]	30.65	3.1170	6.99
Copper	1	12.1900[a]	10,738.00[a]	2.4100	17.43
Color × cream	1	0.1547	115.40	0.4043	4.81
Color × copper	1	0.0214	16.87	0.0650	0.55
Cream × copper	1	0.7729[a]	28.67	0.3413	10.07
Storage	3	2.4190[a]	5,171.00[a]	0.2560	3.44
Storage × color	3	0.0848	15.59	0.0790	0.13
Storage × cream	3	1.0500[a]	26.14	0.1003	2.37
Storage × copper	3	1.4200	3,402.00[a]	0.0334	0.35
Error	77	0.1077	61.54	0.9838	6.43

[a] Significant at $P = 0.01$.

Vitamin A potency. Carotene accounted for 9% of the vitamin A potency in the butter colored with coal-tar and for 30% in that colored with carotene. As shown in Tables 7 and 8, carotene coloring increased significantly the vitamin A potency of the butter by an average of 3800 I.U. per lb. In this study the vitamin A potency of the butter was not affected significantly by storage, cream quality, or level of copper content.

SUMMARY

Synthetic β-carotene was compared with coal-tar as a coloring agent for butter. With a view to duplicating commercial conditions, the comparison was made at two levels of cream quality, two levels of copper and at three periods of storage.

Neither official graders nor a taste panel could detect any flavor difference between the two types of butter. Acid degree, peroxide, and aldehyde values were the same for both types of butter, although copper and storage increased the degree of oxidation. Standardizing the color of butter with 0.35 g. of synthetic β-carotene per 100 lb. of fat gave a slightly deeper color than with 1 oz. of coal-tar color per 100 lb. of fat. The color intensity of the butter did not change during storage. The average vitamin A potency of the butter was increased 3800 I.U. per lb. as a result of coloring the butter with synthetic β-carotene, and was not affected by storage.

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OUR INDUSTRY TODAY

Brief Reviews of Current Topics

Keeping Production Records on Dairy Farms Is the Key to Greater Efficiency and Profits

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Milk production efficiency can be improved and costs lowered when the farmer has the necessary information at hand to guide him in feeding, breeding, and management practices. A record of production on each cow in the herd is the key information needed. The availability of continuous lactation records is the most important tool with which to effect more efficient milk production, and can be the most important guide in proper feeding, breeding, and culling.

Studies of production records and related information on cows in many herds show repeatedly that milk is produced more efficiently and at lower costs by high-producing cows, as compared with low-producing cows. This is illustrated in a 1954-55 DHIA summary:

Level of Production	Feed Cost	Feed Cost per 100 Pounds Milk
5,000 lb.	$136	$2.72
7,000 lb.	203	2.31
9,000 lb.	233	2.00
11,000 lb.	272	1.78

Records of production can be obtained in various ways and may include milk yields alone, or milk and butterfat production. It has long been known that recording the production of the milk and butterfat content of the milk of a cow on one day each month, and totaling the monthly production for the months in milk, give an accurate estimate of the lactation yield. Monthly milk yields can be obtained easily, merely by the use of accurate scales. Butterfat yields require testing the milk for butterfat content. This is less easily done and, because of this, organized production record-keeping programs which provide an unbiased record of the production of individual cows have been developed and have been used for more than half a century.

Role of Production Records in Breed Improvement

Records of production have played a vital part in the development and improvement of the various breeds of purebred dairy cattle. During the last quarter of the past century several breed associations established production-testing programs and at present all of the associations conduct either the advanced registry or herd improvement plans of testing, or both, as a part of the breed-improvement program. Some of these advanced registry programs started out as seven- and 30-day tests of individual cows, but these plans since have given way to 10 months', or yearly, records with calving requirements included. In 1925 the Ayrshire Breeders Association started the herd test by which a participating farmer entered on test all the milk cows in his herd. Other breed associations followed, a few years later, with similar herd-testing programs. At the present time the several breed herd-testing programs, while they vary in some respects, operate in cooperation with the state agricultural colleges in the several states according to uniform rules established by the Purebred Dairy Cattle Association. In spite of the availability of this service, only a relatively small percentage of the registered dairy cattle are maintained on production testing. The number of cows tested by the various breed associations in 1955 is given in the following table:

Number of cows on breed association production testing for the five major dairy breeds[a]

Breed	Period	Herd Select. No. Tested	
Ayrshire	1955[b]	12,762	—
Brown Swiss	1955[b]	8,404	498
Guernsey	1955[c]	28,249	8,268
Holstein-Friesian	Jan. 1, 1956[c]	70,585	2,210
Jersey	Mar. 31, 1956[c]	28,918	1,038

[a] The Milking Shorthorn, Red Dane, and Red Polled Associations also have similar testing programs, with relatively small numbers of cows on test.

[b] Number of records completed.

[c] Number of cows on test.

Development of DHIA Program

In 1905 a group of farmers in Michigan formed an organization that was known as a cow-testing association. It was patterned after the Danish cow-testing association and was designed for use by the owner of either purebred or grade cattle. The purpose was to obtain production records of the members' cows. A supervisor was employed to do the recording and calculation of the records and to determine how much feed was fed and what the feed costs and returns-over-costs were for the cows in each member's herd. The U. S. Department of Agriculture and the state colleges undertook to sponsor testing associations as a means of improving dairy practices on farms and also for the purpose of obtaining result-demonstration information on local herds, for use in education. As this type of program grew in size and importance, it developed into a National Cooperative Dairy Herd-Improvement Program. The original type of testing now is known as the Standard Plan DHIA. It has grown to the extent that on January 1, 1956, there were more than 40,000 herds and 1,400,000 cows enrolled in the program. A record of the growth of Standard Plan DHIA by five-year intervals is shown as follows:

Growth of Standard Plan Dairy Herd Improvement Association Work, 1906-1956

Year	Associations	Herds	Cows on test	Cows per herd
Jan. 1	*(No.)*	*(No.)*	*(No.)*	*(No.)*
1906	1	31	239	7.7
1911	64	——	40,000	——
1916	346	——	150,677	——
1921	452	11,209	193,928	17.3
1926	777	19,540	327,653	16.8
1931	1,112	26,308	510,714	19.4
1936	876	17,344	404,412	23.3
1941	1,383	31,381	763,502	24.3
1946	1,124	23,331	627,878	27.0
1951	2,143	42,949	1,186,615	27.6
1956	2,266	40,984	1,406,306	34.3

The lactation records obtained from the Standard Plan are used in the National Cooperative Sire-Proving Program for the proving of dairy sires. This organized plan of record-keeping has been of tremendous benefit to the participating farmers. This can be illustrated by the fact that all cows on the Standard Plan of testing in 1955 averaged 7,500 pounds of milk, compared to an average of 5,812 pounds for all milk cows in the United States.

Owner-Sampler Plan Introduced

After about 30 years of experience with this testing program, less than four per cent of the nation's dairy cows were on test. The supervisory leaders of the program in some states introduced a new method of record keeping known as the Owner-Sampler Plan. It is operated by the same supervisor who handles the Standard DHIA Plan, but in this plan the farmer weighs the milk and takes the samples, and the supervisor tests the samples and calculates the records. This gives an unofficial record that is intended for the use of the farmer only. On January 1, 1956, about 375,000 cows were being recorded under this plan.

Present Status of Productive Record Keeping

In 1955, in the United States, in total there was about nine per cent of the milk cows kept on farms on one or the other of the existing forms of testing. This is in contrast to about 60 to 70 per cent for Denmark and The Netherlands, and about 40 per cent for Great Britain. This is an unusually small participation in a program of such vital importance to the dairy farmer. In searching for the reasons for this, the one most frequently mentioned is the high cost. On the other hand, the benefits received from a program of record keeping in a herd far outweigh present-day costs.

Development of Weigh-A-Day-A-Month Plan

The need for production records as a guide to more efficient milk production is more apparent than ever, especially for weeding out the low-producing, unprofitable cows. Recent appraisals of the needs of the dairy farmer by federal and state dairy officials, and several farm organizations working for his interests, revealed that perhaps his most important need at present, to aid him in reducing cost of production, is production records. Records will enable dairy farmers to wisely cull, breed, and feed the cows in their herds. Because of this great need, the leaders of the National Cooperative Dairy Herd Improvement Program have recently developed a third and additional method of obtaining production records. It is known as the Weigh-A-Day-A-Month (WADAM) Plan and is an addition to, and not a substitute for, the Standard DHIA and Owner-Sampler Plans. It is being introduced at this time to provide a new service of milk record keeping. At the same time, and for the first time, the Owner-Sampler Plan is being given national recognition.

The WADAM Plan provides a record of the milk yield only, and does not involve the taking of samples for butterfat. The herd owner himself weighs the milk and sends the information to the County Agent, who has it calculated. It is a nonofficial record, but gives the farmer the

information he needs to guide him in feeding and culling. Because of its simplicity it is very low in cost. Some may question the value of production records based on milk alone. It is recognized that this kind of record is not as good as one which includes both milk and butterfat, but is far better than no record. Eckles' book "Dairy Cattle and Milk Production" carries the statement, "It is at least three times as important to weigh the milk as to test it, although both should be done." It is expected that this new record service will appeal to many dairymen with small herds, and also to those with large herds who are not now using the Breed, Standard, or the Owner-Sampler Plans. Participation in the WADAM Plan will probably interest many in taking up one of the other more complete methods of record-keeping.

Thus, dairy farmers now have available to them four different plans for obtaining production records of their cows: the official Breed Association Plan, the Standard, Owner-Sampler, and the Weigh-A-Day-A-Month National Cooperative Dairy Herd Improvement plans.

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ABSTRACTS OF LITERATURE

W. O. Nelson, Abstract Editor

ANIMAL DISEASES

40. Vitamin A deficiency and urolithiasis in range cattle. K. F. SWINGLE and H. MARSH, Mont. Agr. Expt. Sta., Bozeman. Am. J. Vet. Research, 17, 64: 415. 1956.

Blood plasma vitamin A of 46 calves with clinical urolithiasis averaged 15.3 μg. % $\pm$ 7.3. Plasma vitamin A of 112 clinically normal calves in the same herds averaged 18.6 μg. % $\pm$ 6.4, which was a statistically significantly higher value than that of the affected calves. Field studies indicated that urolithiasis also occurred in many calves with adequate vitamin A; therefore, an experimental group of 11 calves was made deficient in vitamin A and compared with a control group of 11 supplemented calves. No signs of urolithiasis developed in either group. No consistent differences in urine silica, viscosity, turbidity, sediment, or crystal content due to vitamin A nutrition were noted. It was concluded that vitamin A deficiency was neither a necessary, nor by itself a sufficient, condition for urolithiasis in range steers.

E. W. Swanson

41. Studies on trichloroethylene-extracted feeds. I. Experimental production of acute aplastic anemia in young heifers. II. The effect of feeding different levels of trichloroethylene-extracted soybean oil meal to young heifers—experimental production of chronic aplastic anemia. III. The use of young calves for study of various aspects of toxicity of trichloroethylene-extracted soybean oil meal. IV. Failure to demonstrate the presence of a toxic factor in the milk of cows fed toxic specimens of trichloroethylene-extracted soybean oil meal. W. R. PRITCHARD, C. E. REHFELD, N. S. MIZUNO, J. H. SAUTTER, M. O. SCHULTZE, and W. E. MATTSON, Minn. Agr. Expt. Sta., St. Paul. Am. J. Vet. Research, 17, 64: 425. 1956.

One to 3 lb. daily of trichloroethylene soybean oil meal was fed to 4 groups of 5 heifers each, and all developed varying degrees of acute aplastic anemia and other signs of illness. All calves in one group died after 35 to 55 days of feeding. No changes occurred in calves fed hexane-extracted soybean oil meal. Five different lots of TCESOM were used in a low-level feeding trial, to produce chronic aplastic anemia. All lots proved toxic, but those processed within 3 mo. of harvest were very toxic; whereas, those processed from beans stored 10 to 16 mo. were low in toxicity. Young calves develop toxic conditions quickly after TCESOM feeding. Trichloroethylene extracted soybean oil was not toxic to calves. The toxic factor in the meal was absorbed from the G.I. tract after by-passing the rumen in one calf. Milking cows fed the toxic meal developed aplastic anemia, but animals fed milk from these cows failed to show any signs of toxicity.

E. W. Swanson

42. Reviews of the progress of dairy science. Section E. Diseases of dairy cattle. P. S. BLACKBURN, Hannah Dairy Research Inst., Kirkhill, Ayr, Scotland. J. Dairy Research, 23, 3: 385. 1956.

This 21-page article reviews 193 original papers relative to the treatment, control, bacteriology, diagnosis, and the general and experimental aspects of mastitis; as well as the diagnosis, bacteriology, vaccination, control, eradication and the general aspects of contagious abortion. J. D. Donker

43. Observation on collagen, vitamin A, and ascorbic acid in bovine hyperkeratosis. C. L. MARSH, C. OLSON, JR., and I. C. BLORE, Nebr. Agr. Expt. Sta., Lincoln. Am. J. Vet. Research, 17, 64: 410. 1956.

Biopsies of skin from the neck were taken from 6 normal calves and 10 calves or cows showing signs of hyperkeratosis. Normal skin contained 22 to 30 g. of collagen per 100 g., compared to low values of 2 to 14 g. from hyperkeratosis-affected animals. It is postulated that the abnormal collagen levels are caused by a deficiency of vitamin A and ascorbic acid which are required for normal epithelial and connective tissues. Treatment of 4 calves with pentachloronaphthalene was found to markedly decrease blood plasma ascorbic acid and vitamin A. E. W. Swanson

44. Infection and mastitis in a dairy herd, 1945-53. J. OLIVER, F. H. DODD, and F. K. NEAVE, N.I.R.D., Univ. of Reading, England. J. Dairy Research, **23**, 2: 169. 1956.

Over a period of eight years and a total of 530 complete lactations, a herd of cattle has been carefully studied from the standpoint of infection and clinical mastitis. Details of the herd history are given relative to herd make-up and management, the bacteriological methods utilized, and method of analysis used to evaluate the observations. J. D. Donker

45. Variation in the incidence of udder infection and mastitis with stage in lactation, age, and season of the year. J. OLIVER, F. H. DODD, F. K. NEAVE, and (the late) G. L. BAILEY. J. Dairy Research, **23**, 2: 181. 1956.

A detailed analysis of 530 complete lactations was used to determine the effect of stage of lactation, age of cow, and season of year upon first infection rate, re-infection rate, total new infection rate, total infection and mastitis incidence by cows and quarters of cows. As lactation progressed the incidence rate of first, re-, and total new infections and mastitis declined. Infection was often accompanied by mastitis in early lactation. Each of the last 4 mo. of lactation was similar in incidence of infection and mastitis, with no apparent rise toward the termination of lactation. The incidence of infection and mastitis increased with age, but infected older cows did not show more clinical signs of mastitis than younger cows. The longer a quarter remained free of infection, the better was its chance of remaining free. Seasonal trends were not definite, but a slightly greater incidence of mastitis was noted in summer. J. D. Donker

46. Antibiotic treatment of mastitis and its effect on the cell content of the milk. P. S. BLACKBURN. J. Dairy Research, **23**, 2: 225. 1956.

Over a three-year period in a milking herd, all quarters infected with coagulase-positive staphylococci or hemolytic streptococci carrying a cell count in excess of 200,000/ml. were treated with penicillin (100,000 u.), a combination of penicillin and dihydrostreptomycin (0.1 g.), or dihydrostreptomycin (0.25 g.). Such treatment was administered for varying lengths of time and resulted in an elimination of organisms from 61% of staphylococcal and 80% streptococcal udder infections. It took as long as 5 weeks in those quarters remaining free of infection, for the cell counts to return to normal. In these cases the polymorphonuclear leucocytes decreased to less than 30% of what they were one week after treatment.

J. D. Donker

47. Udder infections in the "dry period." II. The effect of withdrawing secretion from the dry udder on the incidence of infection. J. OLIVER, F. H. DODD, F. K. NEAVE, and J. M. LEE. J. Dairy Research, **23**, 2: 194. 1956.

Seventy-five Ayrshire and British Friesian cows were used. Milk samples were drawn for bacteriological examination 3 times in the last two weeks before drying off, by intermittent milking from all quarters, from two quarters of each cow at weekly intervals for three weeks, and from all quarters in the fourth and fifth week after drying off. The rate of new infection of the clear quarters at the drying-off period was compared between those sampled weekly after drying off and those sampled during the fourth and fifth weeks. There was no difference in incidence between two treatments, but fewer staphylococcus infections occurred in quarters sampled throughout the early dry period. About 50% of the new infections persisted to freshening. It was concluded that if natural sealing of the teat sinus takes place, it is of little importance in protecting against infection. J. D. Donker

48. Udder infections in the "dry period." III. The method of drying off cows at the end of lactation. J. OLIVER, F. H. DODD, and F. K. NEAVE. J. Dairy Research, **23**, 2: 197. 1956.

A herd of 126 cows was observed over a two-year period in which there were 188 dry periods for study. Drying off took place two months before the next calving or when production had dropped to 7 lb. daily. In the first year, intermittently milked cows (drying off) were milked once daily for 28 days and at 3, 7, and 14 days later, although some became dry before this treatment was completed. In the second year, intermittent milking was modified to once-a-day milking for 14 days, followed by stripping out on the 3rd and 7th days. The "stop" milking group was not milked after the day allotted for animals to go dry. Milk was sampled from all cows previous to drying off and about equal numbers were treated by "stop" and intermittent milking drying-off methods. Rate of infection was determined by sampling during the 5th and 6th weeks of the dry periods and again later, if these results were not in agreement.

New infections occurred in 41 (45.1%) of 91 cows dried off by "stop" milking, and in 42 (43.3%) of 97 cows dried off by intermittent milking (nonsignificant difference). However, ($P < 0.05$) significantly more quarters which were infected at drying off or which had been infected previously ($P < 0.01$) were infected at the time of testing in the dry period. About half of the infections noted in the dry period persisted until calving and about a third of these caused clinical mastitis. It was empha-

sized that in this experiment little difference between groups was shown between the two methods of drying off, but that these animals were not milking heavily upon being dried off.

J. D. Donker

49. Udder infections in the "dry period." IV. The relationship between the new infection rate in the early dry period and the daily milk yield at drying off when milking was ended by either intermittent or abrupt cessation of milking. J. OLIVER, F. H. DODD, and F. K. NEAVE. J. Dairy Research, **23**, 2: 204. 1956.

Cows were dried off by abrupt cessation ("stop") or by intermittent milking, in order that all cows might be dry 8 weeks. The animals on the "stop" method were restricted to a small amount of hay and water for 48 hours after the last normal milking, and were stripped out before being turned in with the herd. The animals dried off by intermittent milking were those having a long calving interval, and were down to about 7 lb. of milk daily at drying-off time. It was found that new infection rate was increased as the yield of milk at drying off increased, and that this increase was not due to age of cow. The rise in infection rate was due mainly to *S. agalactiae*. It was found that there were significantly more ($P < 0.01$) new infections during the dry period in animals which had been hand-stripped, as compared to a group not hand-stripped during lactation.

J. D. Donker

50. Udder infections in the "dry period." V. The effect of teat disinfection at drying off on the incidence of infections in the early dry period. J. OLIVER, F. H. DODD, and F. K. NEAVE. J. Dairy Research, **23**, 2: 212. 1956.

Alternate cows to go dry in a herd were washed with hypochlorite solution (800 p.p.m.), dried, and each teat immersed in tincture of iodine (20 sec. in a 5% solution) two times with 24 hours intervening. Treated animals were observed to have less new infection in the dry period ($P < 0.05$), and this difference among cows not infected on drying off was highly significant ($P < 0.01$). The treatment reduced the infection due to *M. pyogenes* var. *aureus*. *S. uberis* infection rate was not affected.

J. D. Donker

51. Veterinarian's mouth speculum. L. R. MONTGOMERY (assignor of one-half to L. Robert Montgomery, Casselton, N. D.). U. S. Patent 2,775,965. 4 claims. Jan. 1, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 1: 58. 1957.

A speculum is described for permitting a veterinarian to examine the mouth of cattle.

R. Whitaker

BUTTER

52. Elting av smoer under redusert lufttrykk. (Working of butter under vacuum). O. M. YSTGAARD and T. KORVALD. Dept. of Dairy Technol., Agr. Coll. of Norway. Bull. 51, 1956. (English Summary).

The effect of working butter under vacuum on its consisteney and spreadability was studied on thirty-four experimental churnings. The cream was temperature-treated and was churned in one churn. The butter was washed once and worked slightly before being distributed equally between three identical stainless steel churns. In these churns the butter was worked under 20.9, 12 or 0 in. of vacuum, respectively. The working speeds for each churn were 5 r.p.m./10 min., 10 r.p.m./10 min., 15 r.p.m./25 min., followed by 19 r.p.m. until the butter was dry. Samples of the butter were stored for 3 to 6 and 14 days at 13° C. and at –10° C. for 3 mo. before being graded. In addition, the butter was examined for moisture, air content, pH of serum, iodine number, and hardness.

The consisteney of butter made from milk fat with an iodine number below 33.8 was significantly improved by working under vacuum, particularly at 20.9 in. During the period with iodine numbers above 36.2, the consisteney and appearance of butter kept in cold storage was improved at 12 in. of vacuum. The higher vacuum had little effect. Working under vacuum had no significant effect upon flavor and keeping quality. The air content of butter decreased with increased vacuum. Hardness of butter increased with increasing vacuum, but the consistency improved. The butter mass was more compact after the air had been removed, but the elasticity and spreadability of butter worked under vacuum was better than that of the regularly made butter. The improvement was attributed to the release of more butter oil under vacuum.

T. Kristoffersen

53. Methods and apparatus for whipping food products. N. E. SPIESS, JR., E. M. GROPEN, and H. L. HENZE (assignors to National Dairy Research Laboratories, Inc., Oakdale, N. Y.). U. S. Patent 2,774,578. 5 claims. Dec. 18, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 3: 565. 1956.

A continuous method and whipper for food products, such as butter, are described. The product to be whipped is introduced into a whipping chamber by means of screw feed, gas under twice the pressure is metered in, and the product continuously whipped to the predetermined overrun.

R. Whitaker

54. Method of imparting a butter-like flavoring to fat-containing food products and the resulting product. D. R. MERKER (assignor to

Swift and Co., Chicago, Ill.). U. S. Pat. 2,773,-772. 21 claims. Dec. 11, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 2: 358. 1956.

Diacetyl is fortified with a small amount of butyl alcohol. R. Whitaker

CHEESE

55. Controlling the quality of Cheddar cheese. H. L. Wilson, Kraft Foods Co., Chicago, Ill. Milk Prod. J., **47**, 12: 13. 1956.

The importance of an active starter is discussed at great length. The amount of acid development required depends upon both the moisture content desired and the time allowed to make the cheese. When making low moisture cheese in 4½ hr. the milling acidity should be .50 to .65%. Milling acidity for a 5 hr. make should be .55 to .75%; a 4 hr. make .45 to .60%; a 3½ hr. make .40 to .50%. Some variations may be necessary, depending on solids content of the milk and whether moisture content of cheese is to be 34 or 36.5%.

The proper amount and application of salt also has a noticeable effect upon the quality of the cheese. A range of 1.6 to 1.9% is recommended for proper curing and breakdown of a low-moisture Cheddar cheese. Detailed recommendations are presented for proper application of the salt. J. J. Janzen

56. Sur une altération superficielle des fromages à pâte molle et croûte fleurie provouquée par penicillium funiculosum **(Concerning a cheese defect of soft body and flower-like crust caused by "penicillium funiculosum").** J. Keilling, J. Casolis, G. Savignac, and G. Dubreuil, Ind. Agr. Lab. of the Natl. Inst. of Agron. Le Lait, 36: 249. 1956.

In cheese made with *Penicillium candidum* a defect sometimes develops which results in a soft body and violet spots directly beneath the crust. This defect is thought to be due to infection by *Penicillium funiculosum*. It was found in this study that growth conditions for the latter are very similar to those of the former. For this reason, although infection can come from the milk, water, or air, it is thought that major dosages can come from impure cultures of *P. candidum*.

A. W. Rudnick, Jr.

57. Vitamin B_{12} potency of Cheddar, Swiss, and Cottage cheese. A. M. Hartman and L. P. Dryden, U.S.D.A., Beltsville, and R. E. Hargrove, U.S.D.A., Washington, D. C. Food Research, **21**, 5: 540. 1956.

Vitamin B_{12} potencies of several types of cheese were determined using microbiological and rat assay methods. The two methods gave similar results with Cottage cheese, but with other cheeses the rat assay method gave double the values obtained by the microbiological technique. Reasons for this are discussed. Natural Cheddar, process Swiss and Cottage cheese averaged about the same on a dry basis (33 to 38 mcg. per kg.–rat assay). Process Cheddar was less potent (19 mcg.), while natural Swiss was more potent (58 mcg.). F. J. Doan

58. Art of processing and packaging cheese. L. Drangle. U. S. Patent 2,768,572. 1 claim. Oct. 30, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 5: 978. 1956.

A complete unit for the manufacture and packaging of process cheese in heat-sealable containers. R. Whitaker

59. Method of packaging cheese. A. B. Erekson and J. R. Palmer (assignors to The Borden Co., New York, N. Y.). U. S. Patent 2,768,-085. 10 claims. Oct. 23, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 4: 846. 1956.

A block of cheese is placed in an unclosed, heat-sealable film type wrapper. Pressure of from 200 to 400 lbs. per lb. of cheese is applied and the unsealed portion sealed to give an air-free package. R. Whitaker

60. Cheese manufacture. B. T. Hensgen (assignor to Swift and Co., Chicago, Ill.). U. S. Patent 2,768,083. 10 claims. Oct. 23, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 4: 845. 1956.

Curd is cheddared while being conveyed under pressure between two concave-shaped belts. R. Whitaker

61. Apparatus for processing individual cheese rations. E. Locatelli and R. Lomellina. U. S. Patent 2,777,124. 3 claims. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 2: 336. 1957.

An extrusion head is described for producing a cheese product containing threads of colored food substances evenly distributed throughout. R. Whitaker

62. Cheese pump and filler. S. Bowman. U. S. Patent 2,776,626. 6 claims. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 2: 222. 1957.

A piston-type pump for discharging soft cheeses. R. Whitaker

63. Cheese shredder. C. F. Tarrant. U. S. Patent 2,776,479. 5 claims. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 2: 187. 1957.

A hand-operated slicer for shredding cheese into small strips, for use in salads and cooked foods. R. Whitaker

64. Traveling rotary vat strainer. A. E. Nessler and J. G. Hartman (assignors to Kraft Foods Co., Chicago, Ill.). U. S. Patent 2,774,140. 13 claims. Dec. 18, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 3: 451. 1956.

A perforated tray, containing particles of curd, is supported in a cheese vat with round ends, and equipped with a reciprocating agitator for stirring the curd. R. Whitaker

CONDENSED AND DRIED MILKS; BY-PRODUCTS

65. Milk sterilization. Control of gelation in evaporated milk. N. P. TARASSUK and A. F. TAMSMA, Dept. of Dairy Ind., Univ. of Calif., Davis. J. Agr. Food Chem., 4: 1033. 1956.

Gelation of evaporated milk in storage can be controlled by preheating milk in the concentrated state, followed by dilution to standard composition, if necessary, and sterilization. This treatment does not affect the color and flavor of the finished product. The optimum time and temperature of the preheating treatment vary with the concentration of the milk at the time it is preheated. Because of variations in the colloidal characteristics of milk, optimum conditions of the preheating treatment also vary seasonally and with milk from different areas. S. Patton

66. Les propriétés mechaniques des fibres de casein préparées in partant d'α- et de β-caséin (Mechanical properties of casein fibers prepared from α- and β-casein). G. GÉNIN. Le Lait, 36: 399. 1956.

Casein is separated into α and β fractions by the method of Hipp *et al.*, and the fractions firmed into fibers by a formaldehyde or a quinone solution. The resulting fibers were tested for strength and flexibility. It is concluded that β-casein is superior to α-casein and to the nonfractionated casein. Reason for the superiority of β-casein is postulated to be its greater "molecular" weight.

A. W. Rudnick, Jr.

67. L'insolubilisation et le drucissement des crins de casein (Making insoluble and hardening casein fibers). G. GÉNIN. Le Lait, 36: 276. 1956.

A process for forming casein fibers using a formaldehyde-resoreinol mixture is described. It is claimed that if conditions of pH, cooking temperature, and mixture are followed carefully, the resulting fibers have a greater resistance to moisture than usual.

A. W. Rudnick, Jr.

68. Le traitement de la laine par la caséin en vue de réduire son feutrage (The treatment of wool with casein with the object of reducing matting). G. GÉNIN. Le Lait, 36: 501. 1956.

Studies are made concerning the use of casein as a means of reducing matting of wool cloth on repeated washings. It is found that if the wool treated with casein is treated first with a formaldehyde solution at pH 8.69, and then with a formaldehyde solution containing large amounts of electrolytes and acid, the resulting material will be resistant to numerous washings and to hot solutions and acids.

A. W. Rudnick, Jr.

69. Method for canning evaporated and fresh milk. E. M. BORG. U. S. Patent 2,776,213. 1 claim. Jan. 1, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 1: 118. 1957.

A method is described of preparing evaporated milk of optimum flavor in which various quantities of preheated milk are blended to give a uniform finished final product. Blending is done on the degree of fluorescence exhibited by the product when viewed under ultraviolet light. R. Whitaker

DAIRY BACTERIOLOGY

70. Ruminant nutrition. Rumen metabolism of nonprotein nitrogen. W. H. HALE, Dept. of Animal Husbandry, Iowa Agr. Expt. Sta., Ames. J. Agr. Food Chem., 4: 948. 1956.

The role of nonprotein nitrogen in the biochemical processes that occur in the rumen is reviewed, as well as possible mechanisms of toxicity. *In vitro* and animal studies with rumen microorganisms show useful nonprotein nitrogen compounds, in terms of cellulose digestion and bacterial growth, to be those from which the ammonia nitrogen is easily released. Rumen microorganisms show adaptability in utilizing nitrogen from certain nonprotein nitrogen compounds whose nitrogen is generally considered unavailable. Fifty per cent or more of a natural protein entering the rumen may be degraded or altered by rumen microorganisms, with the nitrogen appearing as free ammonia or bacterial protein. S. Patton

71. Rumen microbiology. Formation of short-chain fatty acids from cellulose, starch, and metabolic intermediates by ovine and bovine rumen microorganisms. T. V. HERSHBERGER and O. G. BENTLEY, Dept. of Animal Sci., Ohio Agr. Expt. Sta., Wooster.—J. H. CLINE and W. J. TYZNIK, Dept. of Animal Sci., Ohio State Univ., Columbus. J. Agr. Food Chem., 4: 952. 1956.

Incubation of ovine rumen microorganisms *in vitro* with starch, maltose, or glucose, in combination with cellulose, increased the amount and presumably the rate of formation of acetic, propionic, and butyric acids. Digestion of cellulose by bovine rumen microorganisms *in vitro* was decreased by alanine, α-ketoglutarate, and lactate; whereas, the other metabolic acids added increased the formation of short-chain fatty acids. Approximately 40% of the carbon in cellulose and 50% of glucose was recovered in the short-chain fatty acids. Further evidence is presented to support the hypothesis that the major pathway of propionic acid formation in rumen bacteria involves succinate decarboxylation. S. Patton

72. Catalase production by lactobacilli. J. C. DACRE and M. E. SHARPE. Nature, **178**, 4535: 700. 1956.

Several strains of *Lactobacillus plantarum*, isolated from Cheddar cheese, were catalase-positive. The type of sugar used in the medium influenced the catalase production, with the greatest yield when the glucose content was lowest. R. Whitaker

73. Production of Saccharomyces fragilis with an optimum yield of lactase. H. YOUNG and R. P. HEALEY (assignors to National Dairy Research Laboratories, Inc., Oakdale, N. Y.). U. S. Patent 2,776,928. 4 claims. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 2: 293. 1957.

An improved lactase-rich enzyme preparation is prepared from *Saccharomyces fragilis* by culturing under defined conditions involving the nitrogen content and degree of aeration. R. Whitaker

74. Method of bacterial incubation control and apparatus therefor. S. GAYMONT. U. S. Patent 2,767,118. 1 claim. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 3: 600. 1956.

A means of controlling the rate of growth of lactic acid bacteria by adjustment of the temperature. The process is automatic and depends on electrically sensing the ionization changes in the media. R. Whitaker

DAIRY CHEMISTRY

75. The role of dehydroascorbic and dehydroreductic acids in the browning reaction. S. I. DULKIN and T. E. FRIEDEMANN, Dept. of Physiol. Chem., Northwestern Univ. Med. School, Chicago 11, Ill. Food Research, **21**, 5: 519. 1956.

Evidence was obtained indicating that reductic and ascorbic acids, in buffered or acid solutions, will undergo a browning reaction (not intensified by the presence of amino acids) characterized first by an oxidation to the respective dehydro forms. This appears similar to the browning occurring in heat-processed foods, in that it is accompanied by marked darkening, fluorescence, reducing activity, and acidity. It is suggested that this reaction is partly responsible for the browning of foods, particularly fruits. F. J. Doan

76. Purification of lactase enzyme and spray-drying with sucrose. W. M. CONNORS and T. SFORTUNATO (assignors to National Dairy Research Laboratories, Inc., Islip, N. Y.). U. S. Patent 2,773,002. 7 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 156. 1956.

A culture of yeast, selected because of its high lactase activity, is dried, then agitated for 4 to 20 hours in an aqueous potassium phosphate buffer having a total solids content of from 5 to 15% with a pH of 6.5 to 7.2 at 40° C., then centrifuged to procure a lactase solution. After cooling to 40° F., acetone is added at a rate of from 40 to 50% by weight and again centrifuged to obtain a lactase precipitate. This is suspended in water at an 8% level, centrifuged, and sugar added to bring the total solids of the centrifugate to from 12 to 20%, and then spray dried. This dry preparation exhibits high lactase activity and stability, and gives a good flavor when used in milk products to hydrolyze some of the lactose. R. Whitaker

77. Separation of crystallized lactose from whey solids. D. D. PEEBLES, DAVIS, and P. D. CLARY, JR. (assignors to Western Condensing Co., San Francisco, Calif.). U. S. Patent 2,768,912. 2 claims. Oct. 30, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 5: 1064. 1956.

Whey is condensed until it becomes supersaturated to lactose. The lactose is allowed to crystallize and is then fed continuously into a revolving screen reel. The equipment is so designed and operated that the crystallizing mass becomes progressively more viscous as it continuously passes through the device; until it is finally extruded as a paste, with practically all of the lactose in crystal form. R. Whitaker

78. Enzymatic synthesis of N-acetylglucosaminido galactose and galactosido-n-acetyl glucosamine. P. GYORGY and F. ZILLIKEN (assignors to American Home Products Corp.). U. S. Patent 2,770,573. 4 claims. Dec. 10, 1953. Offic. Gaz. U. S. Pat. Office, **712**, 2: 367. 1956.

Lactose and N-acetyl-d-glucosamine are caused to react together by an enzyme present in growing cultures of *Lactobacillus bifidus*. The enzyme is prepared from the culture by lyophilizing the solid material centrifuged from it, and mixing the dried product with aluminum oxide in the presence of a phosphate buffer. The mixture of N-acetyl-glucosamide galactose and galactosido-N-acetyl-glucosamine thus formed stimulates the growth of *L. bifidus*. R. Whitaker

79. Riboflavin in milk. V. V. MODI and E. C. OWEN. Nature, **178**, 4542: 1120. 1956.

Using paper chromatography, paper electrophoresis, and fluorescence under U.V. light, these authors report progress on a study of the qualitative and quantitative distribution of riboflavin and allied compounds in the milk of the cow, human, mare, sow, ewe, goat, and rabbit. Free riboflavin was found in cow and goat milk, but not in human and mare milk. Flavin adenine dinucleotide was found in human, mare, and sow milk, but this was not due to xanthine oxidase which was not found in these milks but was found in cow, ewe, goat, and rabbit milk. R. Whitaker

80. Determination of calcium and magnesium in foodstuffs. Simultaneous removal of iron and phosphate as interfering ions by ion exchange. W. E. SCHILZ and G. N. KRYNAW, Dept. of Chem., Univ. of Pretoria, Transvaal, South Africa. Analyt. Chem., **28**, 11: 1759. 1956.

Ca and Mg are determined by a simple titrometric method using ethylenediamine tetraacetate and with Murexide and Erichrom Black T as indicators for Ca and Mg, respectively. Iron is removed with a cation exchange resin and the Ca and Mg are eluted with hydrochloric acid and determination in the eluate.

B. H. Webb

81. Une méthode sinacide de dosage de la matière grasse du lait utilisant le matériel Gerber. (A nonacid method for butterfat determination using Gerber equipment.) J. C. GODFRAIN, Natl. Vet. School of Toulouse. Lait, 36: 492. 1956.

A description is made of a butterfat testing technique using a mixture of nonionic and anionic detergents and the apparatus employed in the conventional Gerber test.

A. W. Rudnick, Jr.

82. Use of paper chromatography for in vitro studies of lactose metabolism in mammary-gland preparations. R. HEYWORTH and J. S. D. BACON, Dept. of Biochem., Univ. of Sheffield. Biochem. J., **61**, 2: 224. 1955.

Paper chromatographic methods were developed by which the rate of synthesis of lactose could be measured upon incubation of tissue slices in Warburg vessels. Tissue slices, blends, and mitochondrial suspensions from the lactating mammary glands of guinea pigs and rats were used to study the metabolism of lactose *in vitro*. Lactose was not broken down by respiring tissue slices, blends, or mitochondrial suspensions, but crude aqueous extracts showed some lactase activity, particularly when the pH was lowered. Tissue slices from guinea pigs gave evidence of the synthesis of lactose, but no such synthesis was obtained with rat tissue.

R. Jenness

83. Effects of adrenal corticoids on fatty acid synthesis in mammary gland slices in vitro. M. L. MCNAUGHT, R. F. GLASCOCK, J. H. BALMAIN, and S. J. FOLLEY, N.I.R.D., Univ. of Reading. Biochem. J., **60**, 1: 102. 1955.

The effect of the adrenal corticoids, cortisone, cortisol, corticosterone, and deoxycorticosterone alone and in conjunction with insulin on the incorporation of glucose and acetate labeled with C^{14} or H^3 into the fatty acids of lactating mammary gland slices from rats and sheep was studied. With the slices from rat mammary gland, corticosterone and deoxycorticosterone very markedly inhibited fatty acid synthesis, and cortisone somewhat inhibited it. Cortisol, on the other hand, had no inhibitory effect. With slices from sheep mammary gland, corticosterone and deoxycorticosterone markedly inhibited fatty acid synthesis, cortisol somewhat inhibited it, but cortisone had no effect.

R. Jenness

84. Some properties of alkaline phosphatase of cow's milk and calf intestinal mucosa. R. K. MORTON, Dept. of Biochem., Univ. of Cambridge. Biochem. J., **60**, 4: 573. 1955.

The properties of purified alkaline phosphatases of cow milk and calf intestinal mucosa were studied and compared. Both enzymes are colorless, unconjugated proteins, substantially free of organic phosphate and of nucleotides or related compounds. They have similar tyrosine and tryptophan contents. They may contain small amounts of carbohydrates. The two enzymes differ in their pH activity curves. The milk enzyme has an optimum at pH 9.65 and the intestinal enzyme an optimum at pH 9.45. The influences of various activators and inhibitors were investigated. It was concluded that the two enzymes are distinctly different, although having similar specificities.

R. Jenness

85. The substrate specificity and inhibition of alkaline phosphatases of cow's milk and calf intestinal mucosa. R. K. MORTON, Dept of Biochem., Univ. of Cambridge and Univ. of Melbourne. Biochem. J., **61**, 2: 232. 1955.

Purified alkaline phosphatases from cow's milk and from calf intestinal mucosa were investigated for specificity, using a wide variety of substrates under several different experimental conditions. These enzymes rapidly hydrolyzed all true orthophosphate monoesters. They also hydrolyzed the orthophosphoamide, phosphocreatine, and the enolic phosphate, phosphoenolpyruvate. They did not hydrolyze sodium pyrophosphate, sodium hexametaphosphate, diphenyl pyrophosphate, ATP, ADP, or DPN. Thus, they do not have any pyrophosphatase activity. Furthermore, they failed to hydrolyze partially degraded yeast nucleic acid, showing that they do not have diesterase activity. These enzymes were only slightly inhibited by organic polyphosphates, phosphates, phosphites, phosphonates, and fluorophosphonates. They were strongly inhibited by iodine and cysteine.

R. Jenness

86. The action of purified alkaline phosphatases on di- and tri-phosphopyridine nucleotides. R. K. MORTON, Dept. of Biochem., Univ. of Cambridge and Univ. of Melbourne. Biochem. J., **61**, 2: 240. 1955.

Purified alkaline phosphatases prepared from cow's milk and from calf intestinal mucosa quantitatively converted tri-phosphopyridine

nucleotide (TPN) into di-phosphopyridine nucleotide (DPN). DPN is not hydrolyzed by either enzyme. These results confirm that the third phosphate of TPN is attached by ester linkage to ribose. R. Jenness

87. The branched-chain fatty acids of ox fat. 2. The isolation of 15-methylhexadecanoic acid. R. P. Hansen, F. B. Shorland, and N. J. Cooke, Dept. of Sci. and Ind. Research, Wellington, New Zealand. Biochem. J., **61**, 1: 141. 1955.

A C_{17} branched-chain fatty acid, 15-methylhexadecanoic acid, was isolated in small amount (about 0.06% of the total fatty acids) from hydrogenated ox perinephric fat. R. Jenness

88. The branched-chain fatty acids of ox fat. 3. The isolation of 14-methylpentadecanoic acid (isopalmitic acid) from ox perinephric fat. R. P. Hansen, F. B. Shorland, and N. J. Cooke, Dept. of Sci. and Ind. Research, Wellington, New Zealand. Biochem. J., **61**, 4: 547. 1955.

A C_{16} branched-chain fatty acid, 14-methylpentadecanoic (isopalmitic) acid, was isolated and identified in ox perinephric fat. It is estimated to be present to the extent of 0.1% of the weight of the total fatty acids. R. Jenness

89. Branched-chain fatty acids of butterfat. 7. Investigation of the C_{13} acids. F. B. Shorland, T. Gerson, and R. P. Hansen, Dept. of Sci. and Ind. Research, Wellington, New Zealand. Biochem. J., **61**, 4: 702. 1955.

Three branched-chain acids have been identified in butterfat. They are (+)-10-methyldodecanoic, 11-methyldodecanoic, and n-tridecanoic acid. The amounts of each were estimated to be respectively 0.01, 0.05, and 0.03% of the total fatty acids. R. Jenness

90. The metabolism of citric acid in the mammary gland. 1. The effect of p-nitrophenol on the synthesis and oxidation of citric acid by homogenates of the mammary gland. C. Terner, N.I.R.D., Univ. of Reading. Biochem. J., **60**, 1: 88. 1955.

A study was made of the oxidation and accumulation of citric acid in systems consisting of homogenates of the lactating mammary glands of guinea pigs. These homogenates oxidized citric acid at approximately the same rate as α-ketoglutaric acid. Citric acid accumulated in mammary homogenates metabolizing pyruvate or acetate in the presence of fumarate. It was concluded that the preparation metabolized citrate at a rate corresponding to the over-all rate of the citric acid cycle and that the accumulation of citric acid during the metabolism of its precursors was due to an excessive rate of production of "active acetate" and its condensation with oxaloacetate. This observation suggests an explanation for the occurrence of considerable quantities of citric acid in milk.

The addition of *p*-nitrophenol at a concentration of 2×10^{-4} M greatly enhanced the respiration of mammary homogenates metabolizing pyruvate plus fumarate, oxaloacetate, citrate, and α-ketoglutarate, but had much smaller or no stimulating effects in the presence of succinate, fumarate, malate, and of acetate plus fumarate. These mammary homogenates oxidized acetoacetate and octonoate. Fluoride at a concentration of 0.01 M inhibited the rate of respiration and of substrate disappearance. R. Jenness

91. The metabolism of citric acid in the mammary gland. 2. The effect of p-nitrophenol and of fluoride on the synthesis of citric acid in fluoroacetate-blocked homogenates. C. Terner, N.I.R.D., Univ. of Reading. Biochem. J., **60**, 1: 95. 1955.

A study was made of the synthesis of citric acid in homogenates of the mammary gland of guinea pigs blocked with fluoroacetate. The synthesis was also studied in washed suspensions of kidney cortex. When pyruvate and fumarate were added in equivalent amounts they were almost quantitatively converted to citric acid with an uptake of an equivalent amount of oxygen. The effects of added p-nitrophenol of fluoride and of arsenate on the formation of citric acid in these systems were also determined. R. Jenness

92. Biosynthesis of fatty acids in cell-free preparations. 2. Synthesis of fatty acids from acetate by a soluble enzyme system prepared from rat mammary gland. G. Popjak and A. Tietz, Natl. Inst. for Med. Research, Mill Hill, London, N.W. 7. Biochem. J., **60**, 1: 47. 1955.

A soluble enzyme system was prepared by high-speed centrifugal fractionation of homogenates of the mammary gland of lactating rats. This system was capable of synthesizing fatty acids from acetate. Both short-chain and long-chain acids were synthesized with some preference for the short-chain acids. Neither the mitochondria nor the microsomes of the mammary glands were required for this fatty acid synthesis. Actually, the soluble supernatant had somewhat more synthetic power than the full homogenate. With this soluble enzyme preparation, fatty acid synthesis was activated by ATP. The synthesis of fatty acids by this system was markedly stimulated by oxaloacetate, α-ketoglutarate, and by malonate. It was stimulated to a lesser extent by succinate. It was inhibited by mercury and arsenate and by cyanide and 2,4-dinitrophenol. Azide and fluoride had no inhibitory effect. R. Jenness

93. Biosynthesis of fatty acids in cell-free preparations. 3. Coenzyme A dependent reactions in a soluble enzyme system of mammary gland. A. TIETZ and G. POPJAK, Natl. Inst. for Med. Research, Mill Hill, London. Biochem. J., **60**, 1: 155. 1955.

The soluble enzyme system prepared as described in *Biochem. J.*, **60**, 155, 1955, which synthesizes fatty acids from acetate on addition of ATP was found to contain about 50 micrograms of coenzyme A per ml. This enzyme preparation contained endogenous substrates from which acetyl coenzyme A and higher acyl-coenzyme A compounds could be formed under appropriate conditions. The formation of hydroxamic acids was used to demonstrate the activation of acetate and other fatty acids with coenzyme A in the mammary gland enzyme preparation. Removal of coenzyme A and DPN from the mammary gland enzyme preparation by treatment with an ion exchange resin abolished its ability to synthesize fatty acids from acetate. The effects of various stimulators and inhibitors were examined in relation to mechanisms involving the participation of coenzyme A. R. Jenness

94. The metabolism of phospholipids in the lactating mammary gland of the rabbit. G. A. GARTON, Rowett Research Inst., Bucksburn, Aberdeenshire. Biochem. J., **61**, 3: 402. 1955.

Two lactating rabbits were injected intravenously with inorganic phosphate labelled with P^{32}, and four lactating rabbits were injected with phospholipids in plasma labelled with P^{32}. After about 2 hours, samples of mammary tissue, plasma, liver, and milk were taken. These were analyzed for specific radioactivity of the phospholipids, the inorganic phosphates, and the glycerol phosphates. In the case of the rabbits injected with orthophosphate, the specific radioactivity of the mammary gland and milk phospholipid was greater than that of the plasma phospholipid. This suggests that the phospholipids must have been formed in the gland and secreted into the milk. On the other hand, no radioactivity was detected in the milk phospholipids of the animals which received the labelled phospholipids. Evidence also is presented that the phospholipids may be taken up by the lactating gland from the plasma and degraded to the extent of about 20% in about 2 hours. R. Jenness

95. Phospholipids. 3. On the chromatographic separation of glycerophospholipids. C. H. LEA, D. N. RHODES, and R. D. STOLL, Univ. of Cambridge, and Dept. Sci. and Ind. Research. Biochem. J., **60**, 3: 353. 1955.

Studies were made of the chromatographic separation of egg phospholipids on ion exchange columns, alumina columns, silicic acid columns, and silica impregnated papers. Ion exchange columns proved unsatisfactory as a means of separating these phospholipids. Egg lecithins prepared by chromatographic separation on alumina columns possessed low fatty acid/phosphorus ratios. When rechromatographed on silicic acid they separated into lecithin of a correct fatty acid/phosphorus ratio and lysolecithin. Phosphatidylcholine (lecithin) and phosphatidylethanolamine could be separated in good yield and purity from egg phospholipid by chromatography in methanol-chloroform solution on silicic acid columns. Furthermore, lysophosphatidylethanolamine and lysolecithin prepared from phospholipids of egg yolk treated with rattlesnake venom could be similarly separated on silicic acid columns. Sharp separation of a series of glycerol phospholipids, both natural and synthetic, was achieved on silica-impregnated paper.

R. Jenness

96. The effects of deprivation of carotene and anterior pituitary hormone on the partition of vitamin A in the blood and milk of the cow. R. CHANDA, H. M. CLAPHAM, and E. C. OWEN, Hannah Dairy Research Inst., Kirkhill, Ayr. Biochem. J., **60**, 3: 391. 1955.

The effects of injecting an anterior pituitary preparation on the carotene, vitamin A ester, and vitamin A alcohol in the blood and milk of Ayrshire cows was determined. The preparation used (Ambinon) contained the thyrotrophie, luteinizing, and follicle-stimulating activities of the anterior pituitary. The injections were made both in the presence and in the absence of dietary carotene in the form of green fodder. The data were compared with those for control cows receiving the same dietary treatment. The hormonal treatment increased the vitamin A alcohol in the blood serum and the vitamin A alcohol output in the milk, whether green stuff was present in the diet or not. In the absence of green fodder, the blood contained no vitamin A ester and yet the hormone treatment increased the output of vitamin A ester in the milk. Thus the treatment increased the rate of esterification of vitamin A by the mammary gland. It is suggested that this hormone preparation, like thyroxin, accelerates the mobilization of the liver reserves of vitamin A alcohol into the blood, and hence into the milk, as vitamin A alcohol and vitamin A ester. This hormone may also accelerate the transformation of dietary carotene into vitamin A in the gut. R. Jenness

97. Biosynthesis of proteins. 3. Precursors in the synthesis of casein and β-lactoglobulin. B. A. ASKONAS, P. N. CAMPBELL, C. GODIN, and T. S. WORK, Natl. Inst. for Med. Research, Mill Hill, London, N.W. 7. Biochem. J., **61**, 1: 105. 1955.

Radioactive casein and β-lactoglobulin were obtained from goat milk collected 4 and 3 hours, respectively, after injection of radioactive amino acids. These proteins were partially hydrolyzed with acid and the radioactive peptides isolated. The radioactivity was found to be uniformly distributed within the protein molecule. This indicates that casein and β-lactoglobulin are synthesized from free amino acids of the blood and that peptides for milk protein synthesis are not supplied by partial hydrolysis of plasma protein. Methods and apparatus are described for isolation of peptides from partial acid hydrolyzates of casein and β-lactoglobulin. R. Jenness

DAIRY ENGINEERING

98. The future with automation. D. A. SEIBERLING, Dept. of Dairy Tech., Ohio State Univ., Columbus. Milk Plant Monthly, **45**, 10: 30. 1956.

Automation refers to the over-all development of processes which enable human beings to be replaced by machines, and to control circuits in such a manner as to enable any given job to be carried to completion with a minimum of labor, skill, and judgment. In its highest form it involves the integration of process measurements and control methods with mechanized system of materials handling, capable of transforming a raw material into a finished product with little human participation. The susceptibility of market-milk processing to automation is discussed. Manpower utilization on the processing floor would be limited to: Making connections to unload raw materials that are tanked in, receiving and storing miscellaneous merchandise and paper goods, supervising, packaging, easing, and stacking machinery, manual washing equipment still requiring this type of cleaning, and handling and check-out of finished product. C. J. Babcock

99. Water conservation pays in dairy plants. H. J. BARNUM, Denver Dept. of Health and Hospitals. Milk Prod. J., **47**, 11: 42. 1956.

The installation of water-conservation devices in dairy plants in the Denver area has resulted in phenomenal reductions in the amount of water consumed. Conservation measures were necessitated by an acute water shortage resulting from continued drought.

The av. water-to-product ratio factor was 10.43 to 1 in Jan., 1955. This factor varied from 4.3 to 17.28. In June, 1955, following conservation measures, the factor had been reduced to an av. of 5.55. Some of the means by which conserrvation was accomplished were: installing automatic shut-offs on hoses, repairing leaky valves, replacing holding-method pasteurizers with HTST, and numerous reclaiming operations. Three specific examples of plant savings are presented. In general, estimated savings in water costs will pay for the water-saving devices in 5 or 6 years. J. J. Janzen

100. Know stainless steels when selecting for equipment. W. E. MCFEE, Armco Steel Corp., Middletown, Ohio. Ind. and Eng. Chem., **48**, 11: 1964. 1956.

The surface of stainless steel is normally corrosion-resistant to a wide variety of corrosive environments. This appears to be due to the formation of a thin protective film of oxides which, if damaged, may be reformed. The unique corrosion-resistant characteristics of stainless steels may be enhanced by selection of the proper alloy for the medium and temperature, attention to equipment design, and careful cleaning and passivation. B. H. Webb

101. An engineer looks to the future. C. W. HALL, Mich. State Univ., East Lansing. Milk Plant Monthly, **45**, 10: 34. 1956.

Trends are in motion indicating a 5-day week, bulk pick-up, automatic processing, and a concentrated product in the dairy plant of the future. C. J. Babcock

102. Pipeline milk transportation—Austrian style. G. H. WILSTER, Ore. State Coll., Corvallis. Milk Dealer, **46**, 2: 50. 1956.

A plastic tube 7,000 ft., or $1\frac{1}{3}$ mile, long is used to transport milk in Austria. Its inside diameter is 11 mm. and the tube wall is 2 mm. thick. It weighs 76 grams per meter, or $\frac{3}{4}$-ounce per ft. This method of transporting milk has been in use 2 years. It has proved so satisfactory that 20 plastic tube installations are now used for milk in the Alps of Germany, Italy, Switzerland, and Austria. C. J. Babcock

103. Returflaske—automat ("Automatic" bottle return). ANON. Nordisk Mejeri-Tidsskrift, 22: 144. 1956.

Glembring, Engineers, Gotenburg, Sweden, have constructed a machine which receives and sorts glass bottles. The machine is intended for use in self-service stores for bottle return. Up to 10 types of bottles can be sorted at one time. The machine returns receipts to the customer according to the value of the bottles returned. T. Kristoffersen

104. Method for processing milk products. R. R. GRAVES (assignor to The Graves-Stambaugh Corp.). U. S. Patent 2,772,979. 5 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 151. 1956.

A process is described for canning sterilized whole milk which has the flavor and odor of fresh milk and possesses good keeping qualities. The important feature is a pre-sterilizing vacuum treatment which reduces the oxygen content to about 0.09 vol. %. The treated milk

is then homogenized, sterilized, and aseptically canned without contact with air. The finished product has about 0.05 vol. % oxygen.
R. Whitaker

105. Double-acting valve. A. H. Boileau, C. J. Rayman, and F. S. Board (assignors to Cherry-Burrell Corp., Wilmington, Del.). U. S. Patent 2,772,693. 3 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713,** 1: 78. 1956.

A combination piston type and a spring-loaded sanitary valve is described.
R. Whitaker

106. Method and apparatus for opening and emptying paper containers. L. Plusquellic (assignor to National Dairy Research Laboratories, Inc., Islip, N. Y.). U. S. Patent 2,772,009. 10 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712,** 4: 746. 1956.

Details are given for the construction of a machine for automatically opening and draining returned liquid dairy products in paper containers. The containers are placed on their side on a conveyor which moves them against a revolving sharp-edged disc. The slit containers are then twisted, to permit drainage of the product into a tank, and the empty containers are discharged into a bin for discarding.
R. Whitaker

107. Apparatus for sterilizing food containers. W. McK. Martin (assignor to James Dole Engineering Co.). U. S. Patent 2,771,645. 4 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712,** 4: 655. 1956.

Details are given for the construction of a device for sterilizing a continuous series of cans or containers for use in aseptic canner.
R. Whitaker

108. Apparatus for sterilizing container covers. W. McK. Martin (assignor to James Dole Engineering Co.). U. S. Patent 2,771,644. 4 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712,** 4: 654. 1956.

Details are given for the construction of a device for sterilizing a continuous series of can lids for use in an aseptic canner.
R. Whitaker

109. Apparatus for sterilization of canned foods. T. J. Kearney (assignor to Detrex Corp., Detroit, Mich.). U. S. Patent 2,771,023. 11 claims. Nov. 20, 1956. Offic. Gaz. U. S. Pat. Office, **712,** 3: 486. 1956.

A continuous sterilizer is described in which sealed cans are rolled through a chamber containing a heated vapor of a chlorinated hydrocarbon.
R. Whitaker

110. Dispenser for concentrates. C. C. Bauerlein (assignor to The Dole Valve Co., Chicago, Ill.). U. S. Patent 2,766,910. 8 claims. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711,** 3: 551. 1956.

Details are given for a venturi type mechanism which meters a liquid concentrate into a stream of water feeding a dispenser for recombined milk, fruit juices, etc.
R. Whitaker

111. Machine for forming carriers for rectangular milk cartons and method of packagign such cartons in pairs. W. B. Fahrenbach and F. B. Stone (assignors to Edlo, Inc., San Francisco, Calif.). U. S. Patent 2,766,567. 13 claims. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711,** 3: 463-464. 1956.

A method of fastening two quart paper milk containers together. The method depends on the container having a ridge or flange around the top edge of the container.
R. Whitaker

112. Dairy wax composition. R. M. Bailly, L. Silver, and H. F. Hitchcox (assignors to Esso Research and Engineering Co.). U. S. Patent 2,758,100. 8 claims. Aug. 7, 1956. Offic. Gaz. U. S. Pat. Office, **709,** 1: 190. 1956.

Details are given for the composition and manufacture of an improved wax for paper milk bottles, cups, containers, etc.
R. Whitaker

113. Machine for making flat-topped paper bottles. J. F. Earp (assignor to Ex-Cell-O Corp.). U. S. Patent 2,770,175. 12 claims. Nov. 5, 1952. Offic. Gaz. U. S. Pat. Office, **712,** 2: 269. 1956.

A machine is described for assembling paper milk bottles, the tops of which are flat.
R. Whitaker

114. Pasteurizer. H. B. Saunders (assignor, by mesne assignments, to The Schlueter Co., Janesville, Wis.). U. S. Patent 2,776,777. 3 claims. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714,** 2: 259. 1957.

A batch pasteurizer is described for pasteurizing small lots of milk on the farm or in the home.
R. Whitaker

115. Anti-foam filler means. E. P. King (assignor of thirty per cent to Carley Daniel, thirty percent to Reuben W. Peterson, and ten per cent to Elgin Milk Products Co., Inc., all of Galien, Mich.). U. S. Patent 2,775,486. 5 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat. Office, **713,** 4: 789. 1957.

A valve, containing a perforated disc, which delivers liquids of varying viscosity such as skimmilk, milk, cream, etc., into a container without forming foam.
R. Whitaker

116. Apparatus for cleaning pipelines. Z. O. St. Palley. U. S. Patent 2,771,892. 4 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712,** 4: 717. 1956.

Two enclosed tanks provide the important feature of this CIP cleaning system. The cleaning solution in one tank is forced, by means of compressed air admitted to the tank, through the pipe line into the other tank which is vented to the atmosphere. Automatic controls, using photoelectric cells, reverse the flow when the first tank is empty. R. Whitaker

DAIRY PLANT MANAGEMENT AND ECONOMICS

117. Accelerated depreciation may help you modernize now. H. J. Ashe. Milk Prod. J., **47**, 12: 18. 1956.

The author discusses the pros and cons for using an accelerated depreciation formula, permissible ever since adoption of the 1954 Internal Revenue Code. This provision in the Code was enacted deliberately as a calculated means by which to encourage modernization of American business and, indirectly, penalize obsolescence.

The inducements to its use are twofold: (1) Faster recovery of capital outlay; (2) Greater tax savings in the first years of asset lives.

By pre-1954 convention straight-line depreciation methods, capital recovery was slow—only 50% in the first half of an asset's useful life. Adopting either the double declining-balance method or the sum-of-the-years digits method, about ⅔ or ¾, respectively, of the cost is recovered in the same period. This greater recovery and tax savings during the first years of asset lives is most welcome, making the outlay less burdensome. Specific examples of how the Double Declining-Balance and Straight-Line Depreciation methods compare in actual practice are presented, along with a table comparing the tax savings during the 10-year life of the assets.

An accelerated depreciation method may be used for tax purposes only if the depreciable new property was acquired after 1953, and provided the owner is (a) the first user, (b) his use started after 1953, and (c) the asset has a useful life of at least 3 years.

Building improvements are also eligible for faster depreciation. A brief discussion on how to differentiate between eligible and noneligible costs is presented. J. J. Janzen

118. Year-end bonus payments. P. Lockwood. Milk Dealer, **46**, 3: 52. 1956.

A guide, in question-and-answer form, for developing a bonus plan that gives maximum income tax savings and helps to avoid administrative problems. C. J. Babcock

119. Know wage-hour requirements. N. Brown, Dept. of Labor, Washington, D. C. Milk Plant Monthly, **45**, 11: 16. 1956.

A discussion of the Fair Labor Standards Act, more popularly known as the Federal Wage-Hour Law which requires: 1. A minimum of $1 an hour, beginning March 1, 1956. 2. Overtime pay for at least time and one-half the employee's regular rate for all hours worked over 40 a week. 3. A minimum age of 16 years for most jobs, and 14 for a few jobs. In addition, there is an 18-year age minimum for work in occupations designated hazardous by the Secretary of Labor. Details of "First Processing"; "Area of Production"; "Outside Buyers"; "Whitecollar"; and "Motor Carrier" exemptions are given. Employees are required to keep records of wages, hours, and certain other specified items that most employers keep for their own information. C. J. Babcock

120. Around Chicago milk's going bulk. D. H. Murphy, Pure Milk Assoc., Chicago, Ill. Milk Dealer, **45**, 11: 44. 1956.

The quantity of milk coming in bulk to receiving plants in the Chicago market is nearing 40%. Most farmers on this market have been purchasing a tank that will hold at least 3 milkings at the peak production period. For the average, this means a 200-gal. tank which costs from $1,800 to $2,500. Many banks and lending agencies have financed tanks on an assignment of 20 to 30¢ a cwt. of milk. Nearly all receiving stations are paying 25¢ a cwt. for bulk milk. This may not continue more than a year, but a 15¢ premium looks secure for the next few years and perhaps indefinitely. The financing terms are set up anywhere from 2 to 6 years. In 6 years a farmer can pay for his tank with an assignment of 20¢ a cwt. C. J. Babcock

121. The dairy department—top profit for grocers. T. F. Graf, Univ. of Wis. College of Agr., Madison. Milk Plant Monthly, **45**, 8: 26. 1956.

The dairy department of the retail store is more profitable than the other departments. A recent study by the Super Market Merchandising Research Panel revealed that the dairy department outranks all other major departments in dollar sales per sq. ft. of store space. The weekly sales per sq. ft. for various supermarket departments are: 1. Dairy department, $12.87. 2. Produce, $4.31. 3. Meats, $3.60. 4. Groceries, $2.85. Average (entire store), $2.74. C. J. Babcock

122. Milk distribution changing patterns. H. V. Smith and L. F. Herrman, U.S.D.A., Washington, D. C. Milk Dealer, **46**, 3: 44. 1956.

Where data for a 4- to 5-yr. period are available they show that sales of homogenized milk have steadily increased, and regular milk sales have decreased. Deliveries of fluid milk

to the home have generally decreased and store sales have increased. Important in this shift has been the popularity of the gal. and ½-gal. jugs. Increases in sales of these containers were largely at the expense of the qt. Sales in glass are declining and giving way to sales in other containers. The sales of homogenized and regular milk, percentage of fluid milk sold in glass and paper containers, and the percentage of fluid milk sold in various sizes of containers are graphically shown.

C. J. Babcock

123. $50,000 additional sales on retail routes. J. WEBER, Univ. of Idaho, Moscow. Milk Dealer, **46**, 3: 48. 1956.

A survey of the larger customers on retail milk routes in Moscow, Idaho, revealed that of the regular retail-route customers 59% regularly purchase milk and 95% regularly purchase cottage cheese, ice cream, or butter from sources other than the routeman. This indicates that the regular retail-route customers in Moscow spent $150,000 per year for dairy products from sources other than the routeman.

C. J. Babcock

124. The right way to analyze sales. W. Fox, Babcock Dairy, Toledo, Ohio. Milk Dealer, **46**, 1: 68. 1956.

A dairy cannot operate at peak efficiency without making sales comparisons by specific products, from one period to the next, so that any weakness can be detected immediately. Machine methods are described which make unit sales analysis practical for dairies that could not consider it previously, because of the time involved. An over-all dollar sales breakdown by main sales classifications is also described.

C. J. Babcock

125. Expanding our dry milk markets. ANON. Milk Prod. J., **47**, 12: 15. 1956.

The recommendation is made to fortify fluid whole milk and skimmilk with nonfat dry milk solids as a means of expanding our dry milk markets and increasing the nutritional value of our milk. The addition of 1 lb. of solids-not-fat to 100 lb. of regular whole milk will increase the nonfat solids approximately 11%. This means an 11% increase in the nutritional value of the nonfat solids portion of the milk, with the additional calorie count being almost insignificant. The cost of such addition, based on the current selling price for nonfat dry milk, would be about ⅓ to ½¢ per qt. of milk.

The addition of nonfat milk solids to other products such as half-and-half, evaporated milk, and fluid cream is also suggested.

J. J. Janzen

126. What consumers prefer and buy. L. B. BLAKLEY and K. B. BOGGS, Okla. A. and M. Coll., Stillwater. Milk Plant Monthly, **45**, 9: 24. 1956.

A survey of a stratified 1% sample of families or households in Oklahoma City showed that the size of family had more influence than annual income on the amount households spent for dairy products. About 95% of the families used fresh fluid milk and consumption per family averaged about 9 qts. per week. About 19% of the families used powdered milk and about 51% used canned milk. For the total fresh, powdered, and canned milk, families of the same size used about the same amount of milk, regardless of income. Males up to 20 years of age drank from 3 to 3½ glasses per day on the average. In the 20 to 70 years age group, the daily consumption declined to a range of 2.0 to 2.7 glasses per day. After age 70, consumption tended to increase a little. Females up to 20 years of age drank less milk each year. At age 20, they drank an average of 2.1 glasses per day as compared with 3.4 glasses at age one. From 20 to 70 years of age, consumption ranged from 1.3 to 1.9 glasses per day, which was about one glass less per day than for males. Daily consumption by females also increased slightly after age 70. Data are also given showing preference for home delivery, frequency of purchase, and that consumer preference can be influenced.

C. J. Babcock

127. "Leaseback" financing of new plants. G. R. JOHNSON, Hertel, Johnson, Eipper, Stopa, Architects and Engineers, Chicago, Ill. Milk Dealer, **45**, 12: 44. 1956.

Many variations in detail and degree exist in lease-financing agreements. Its basic procedure is that a contractor, lending agency, or other financier provides land, constructs a new plant for the dairy or ice cream operation, and leases the entire package to the client for a uniform monthly rental. Its desirability exists where capital funds are not available through reserves, issuance of stocks or debentures, or private loans, and where company policy of maintaining working capital for other purposes does not allow ownership. Furthermore, it seems that advantages of lease agreements for new construction justifies serious analysis by plant owners who need new or expanded facilities. If adequate precautions are taken to overcome disadvantages, this financing procedure could well allow substantial construction to proceed that might otherwise be impossible.

C. J. Babcock

128. Building home delivery sales. ANON. Milk Dealer, **46**, 1: 64. 1956.

The planned programs used by Dellwood Dairy to find new customers and to keep old ones in the New York City Metropolitan market are discussed. It is pointed out that 2, 3, 4, and 10% of all sales are made on the first,

second, third, and fourth call, respectively, and that 81% of the sales are made on subsequent calls. C. J. Babcock

129. Quality must be controlled every day. W. H. CHADDERDON, Areade Farms Co-op., Inc., Blasdell, N. Y. Milk Plant Monthly, **45**, 12: 34. 1956.

An efficient system for a quality control program is presented from the viewpoint of management rather than from a technical standpoint. C. J. Babcock

130. Farm-to-plant bulk milk handling costs. D. B. AGNEW, Agr. Mktg. Ser., U.S.D.A. Agr. Marketing, **1**, 2: 6. 1956.

The investment in milk-receiving equipment ranges about ⅓ to ⅖ lower for bulk than for can systems of handling milk. This amounts to $6,000 to $15,000, depending on size of plant. With bulk, more flexibility in receiving schedules is possible, but more storage is needed. Estimated savings in receiving and cooling bulk milk at plants range from 5 to 25¢ per cwt. Most of the plant savings come from less use of refrigeration, utilities, and cleaning supplies. Rates charged to farmers for hauling are commonly 5 to 25¢ per cwt. lower for bulk than for can. The milk hauler's investment per truck is higher. On farms, the cost of cooling and handling of milk is higher for bulk than for can, except for large volumes. The fixed costs on farms are also higher for bulk systems. In January, 1956, there were about 30,000 milk tanks on farms, nearly double the number a year earlier. The shift from can to bulk systems among milk plants, milk routes, and farms will likely continue, and the rate may increase. C. J. Babcock

131. Bulk milk handling costs, farm-to-plant. D. B. AGNEW, Agr. Mktg. Ser., U.S.D.A. Seventh Southwest Marketing Conference, Oklahome A & M College, May 17, 1956.

The comparison of investments and costs for bulk and for can systems of handling milk farm-to-plant may be summarized as follows: 1. At milk plants investments and costs are considerably lower for bulk-receiving than for can-receiving systems. 2. For milk trucks, investments and operating costs are about the same to slightly higher for tanker than for can operations; for milk hauling, opportunity exists in many areas for moderate cost savings through route reorganization and skip-a-day milk collection. 3. On farms, investments and costs for cooling and holding milk are moderately to substantially higher for new bulk tanks than for existing can systems. 4. When the shift to bulk handling commences in an area, dairy farmers are likely to feel the effect of these investment-and-cost relationships—the total change at the plant, on the route, and on the farm—in the form of pressure to install bulk equipment and to increase milk production.

It is predicted that the shift to bulk milk handling, farm-to-plant, will continue. C. J. Babcock

132. Meeting seasonal problem of dairy cooperatives through education. S. F. KRAUSE, Farmer Co-op. Service, U.S.D.A., Bull. 9. 1956.

This study is concerned with the methods dairy cooperatives are using to meet the problem of seasonal milk production. It also makes some attempt to evaluate results of these programs.

It is concluded that it is possible for the organizations to obtain a comparatively uniform pattern of seasonal production. However, the cooperative must provide a suitable price incentive, provide thorough and well-balanced programs of education and information, and set up the program on a long-range, continuing basis. A. W. Rudnick, Jr.

133. Plastic case for transporting packaged fresh milk. A. W. KNIERIEM and L. C. FOLST (assignors to Calresin Ind., Inc., Los Angeles, Calif.). U. S. Patent 2,773,624. 3 claims. Dec. 11, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 2: 320. 1956.

A milk bottle case made of plastic. R. Whitaker

134. Dairy order indicator. F. M. CRONENWETT (assignor to H. S. Crocker Co., Inc., San Francsico, Calif.). U. S. Patent 2,771,854. 3 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712**, 4: 708. 1956.

A device for inserting in an empty milk bottle to indicate what products are desired by the customer from the route delivery man. R. Whitaker

FEEDS AND FEEDING

135. Amino acids in feedstuffs. Essential amino acid content of farm feeds. C. M. LYMAN, K. A. KUIKEN, and F. HALE, Texas. Agr. Expt. Sta., College Station. J. Agr. Food Chem., 4: 1008. 1956.

One hundred and fifteen different feed ingredients and related products were analyzed for each of the 10 essential amino acids. The classes of materials include the following: algae (used as feed ingredients in England), animal by-products, fermentation feeds, fish by-products, grains, grain by-products from milling and processing, oilseed residues, peas, and beans. The determinations were made by the use of microbiological assay procedures which have been studied and improved by the authors over a period of years. Amino acid content of feed ingredients has become an

important factor in modern concepts and practice in feed formulation for poultry and swine.
S. Patton

136. Grassland and the feeding of livestock. H. D. KAY. Nature, **178**, 4533: 576. 1956.

In a review of six papers given at a symposium in Reading, England, held by the Nutrition Society, the following subjects were discussed: (1) Factors influencing grassland maintenance, including type of grasses, fertilizer practice, amount of grazing, etc. (2) The role of nitrogenous fertilization to growth of grass. (3) The value of fertilizer in increasing grass production as opposed to an equal value of purchased feed for cows. (4) Methods of assessing the productivity of pastures and grassland. (5) The effects of spring grass on rumen digestion and metabolism of cows, especially in relation to hypomagnesaemia. (6) The influence of pasture on the vitamin A and carotene content of milk from cows grazed on grass.
R. Whitaker

137. Winter feeding of dairy cows. III. The influence on milk yield of high and low protein concentrates, each fed at two levels in addition to dried grass and grass silage. D. REID and W. HOLMES, Hannah Dairy Research Inst., Kirkhill, Ayr, Scotland. J. Dairy Research, **23**, 2: 159. 1956.

Eight milking Ayrshires were divided into two equal groups according to performance, and the four animals in each group were allotted to four treatments and shifted about among treatments in four periods in a Latin-square design. The four variables studied were two rates of feeding concentrate at two levels of protein, as follows: (1) 4 lb./gal. of high protein (18.4%) concentrate, (2) 4 lb./gal. of low protein (11.4%) concentrate, (3) 2 lb./gal. of high protein concentrate, (4) 2 lb./gal. of low protein concentrate. The concentrate was fed in addition to measured ad lib. feeding of dried grass and silage. The higher rate of concentrate allowed the animals to eat 2.0 lb. more dry matter daily and to produce 1.2 lb. more milk while consuming 4.3 lb. less of grass dry matter (0.68 lb. of dry grass less for each 1.0 lb. concentrate).

The level of protein in the concentrate had no significant effect on consumption rate, and a slight positive effect on milk production. Under conditions of the experiment, the lower rate of concentrate feeding was most profitable.
J. D. Donker

138. Feeds containing animal protein factors, vitamin B_{12} and other growth-promoting factors. B. MAKI and I. USHIKOSHI (said Ushikoshi assignor to said Maki). U. S. Patent 2,773,770. 1 claim. Dec. 11, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 2: 357. 1956.

Various types of vegetable feed material are wet with corn juice and fermented with *Neurospora crossa* for 1 to 4 days at from 20 to 44° C., then fermented for at least another day, in the same temperature range, with *Rhizopus nigricans*. The mass is then dried and pulverized.
R. Whitaker

139. Possible use of sorbic acid as a preservative for corn silage. D. K. SALUNKHE. Nature, **178**, 4543: 1187. 1956.

Laboratory experiments showed that when corn silage was sprinkled with 0.1% solution while filling glass jars, mold growth was significantly arrested and the silage was in good physical condition after 5 months at room temperature.
R. Whitaker

GENETICS AND BREEDING

140. Crossbred dwarfs in beef cattle. M. F. BURRIS and B. M. PRIODE, Va. Agr. Expt. Sta., and U.S.D.A., Front Royal. J. Heredity, **47**, 5: 245. 1956.

Five dwarf calves from Angus × Hereford and reciprocal matings were produced in 1955 and 1956. During the same period, four Angus or Hereford dwarfs and 33 normal calves were produced within the same group of cattle. The nine dwarf calves were phenotypically indistinguishable, whether their purebred parents were from the same or different breeds and whether the parents were normal or the shorter type Hereford, i.e., heterozygous. Body weights on two crossbred dwarfs adjusted to 120-day weights were greater than those for two purebred dwarfs similarly adjusted.

It was concluded that the evidence supported the hypthesis that the same gene was involved in both breeds. Hybrid vigor in the crossbreds was suggested.
L. O. Gilmore

141. Rate of heat production by bull spermatozoa. S. BERTAND and M. C. PROBINE. Nature, **178**, 4539: 933. 1956.

Using a micro calorimeter, based on the "Calendar Radio-Balance," the authors showed that heat is produced in unbuffered bull semen under anaerobic conditions in excess of that calculated to be required for propulsion.
R. Whitaker

142. The influence of milk yield on fertility in dairy cattle. E. J. CURRIE, New Zealand Dairy Board, Wellington. J. Dairy Research, **23**, 3: 301. 1956.

The effect of production level on fertility was tested on 9,234 cows in 524 herds in New Zealand. A comparison was made between the levels of production of mature healthy Jersey cattle conceiving to first service and those not. The period of first service used was restricted to a period of 30 days after calving and before 90 days after calving. No effect of level of production upon fertility was noted.
J. D. Donker

HERD MANAGEMENT

143. Milk production and interval between milking. C. P. McMeekan and P. J. Brumby. Nature, **178**, 4537: 799. 1956.

In a carefully conducted experiment it was demonstrated that there is no significant difference in milk or fat production by cows milked at equal 12-hour intervals or at intervals of 8 and 16 hours. R. Whitaker

144. Device for weaning young animals. R. A. Zottoli. U. S. Patent 2,773,475. 3 claims. Dec. 11, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 2: 282. 1956.

A false nipple is mounted in the center of a pail. R. Whitaker

145. Milk filter or the like. L. L. Kramer. U. S. Patent 2,772,785. 8 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 103. 1956.

A milk filter on the top of a milk can is described for farm use. R. Whitaker

146. Milking-machine timing device. T. Asti. U. S. Patent 2,772,689. 14 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 77. 1956.

Details are given for a device for causing pulsations in a vacuum-operated milking-machine. R. Whitaker

147. Cattle stanchion and latch. P. O. Schilling and A. G. Mayer (assignors to Gardner Mfg. Co., Horicon, Wis.). U. S. Patent 2,772,661. 8 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 70. 1956.

A stanchion for holding cows in a stall is described. R. Whitaker

148. Portable milk pasteurizer. O. C. Hoggren. U. S. Patent 2,769,564. 1 claim. Nov. 6, 1956. Offic. Gaz. U. S. Pat. Office, **712**, 1: 109. 1956.

A pasteurizer is described for processing small quantities of milk on the farm. R. Whitaker

149. Nostril attached calf and cow weaner. O. D. Blosser. U. S. Patent 2,765,774. 6 claims. Oct. 9, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 2: 260. 1956.

A description is given of a device for attaching to the nostrils of a calf, to prevent nursing at the udder. It consists chiefly of pointed wires so positioned that they prick the calf if suckling is attempted. R. Whitaker

150. Barn-gutter cleaner. A. F. Klinzing. U. S. Patent 2,768,734. 8 claims. Oct. 30, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 5: 1020. 1956.

An endless conveyor type of barn-gutter cleaner discharging the refuse into a collection zone at the end of the gutter. R. Whitaker

151. Insecticide applicator for livestock. V. E. W. Anderson. U. S. Patent 2,768,608. 2 claims. Oct. 30, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 5: 987. 1956.

An insecticide is applied to livestock as they rub against the side of this apparatus. Movement of the animal activates a pump which forces the solution into tubes equipped with wicks. The liquid drains from the tubes into a reservoir when the animal discontinues rubbing. R. Whitaker

152. Feeder device for livestock. W. V. McClure, Jr. U. S. Patent 2,768,607. 1 claim. Oct. 30, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 5: 987. 1956.

A frame for holding roughage. R. Whitaker

153. Automatic stopping mechanism for milking machines. H. E. Schultheis. U. S. Patent 2,766,722. 11 claims. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 3: 504. 1956.

A fluid-actuated valve for stopping a mechanical milker automatically when milking is complete. R. Whitaker

154. Cartridge-powered cow dehorner. R. D. Hoffman. U. S. Patent 2,766,525. 9 claims. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 3: 453. 1956.

A sliding blade is propelled by the gas released by firing a cartridge in the handle of the dehorner. R. Whitaker

155. Vacuum milk tank. L. A. Blackburn. U. S. Patent 2,767,962. 8 claims. Oct. 23, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 4: 817-818. 1956.

An insulated tank is described for cooling and holding milk under vacuum. R. Whitaker

156. Barn-cleaning apparatus. C. M. Firkins. U. S. Patent 2,776,771. 1 claim. Jan. 8, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 2: 258. 1956.

A barn-gutter cleaner consisting of a mechanism for collecting the debris in a bucket and discharging it into a container at a higher level. R. Whitaker

157. Air injection milking machine device. A. E. Anderson. U. S. Patent 2,775,955. 2 claims. Jan. 1, 1957. Offic. Gaz. U. S. Pat. Office, **714**, 1: 55-56. 1957.

A milking-machine is described which is operated by pulsations created by a valve arrangement and two sources of liquid pressure—one high and one low. R. Whitaker

158. Milking-machine claw assembly. C. R. Brown and R. I. Rofshus (assignors to National Cooperatives, Inc., Chicago, Ill.). U. S. Patent 2,775,225. 6 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 4: 724. 1957.

Construction details are given for a milking-machine claw. R. Whitaker

159. Adjustable biased claw support. E. Rawson and M. M. Pellar (assignors by mesne assignments, to Package Machinery Co.). U. S. Patent 2,775,224. 3 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat Office, **713**, 4: 724. 1957.

A support for holding a milking claw in contact with a cow's udder. R. Whitaker

160. Milk-line releasing apparatus. W. T. Pickavance (assignor to National Cooperatives, Inc., Chicago, Ill.). U. S. Patent 2,775,223. 7 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 4: 724. 1957.

A pipe-line system is described for collecting milk from vacuum-operated milkers.
R. Whitaker

161. Calf delivering instrument. H. L. Quist. U. S. Patent 2,774,353. 3 claims. Dec. 18, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 3: 506. 1956.

A device is described for assisting a cow during calving. R. Whitaker

ICE CREAM

162. Enzymatic hydrolysis of lactose to control the sandiness defect in ice cream. T. W. Albrecht and J. P. Gracy, Univ. of Tenn., Knoxville. Ice Cream Rev., **40**, 5: 22. 1956.

Hydrolysis of varying amounts of lactose in ice milk and ice cream mixes was carried out by adding lactase at the rate of 1% of the estimated lactose content to the mixes. The mixes were then held at 45° F. and a portion of each mix frozen after 0, 1, 3, and 5 days, respectively. Samples of the frozen products were stored at 3° F. and checked periodically for flavor and body and texture. At this temperature, it required seven to eight weeks for sandiness to develop in the control samples and in samples hydrolyzed for one day. No sandiness was observed in the samples hydrolyzed for 3 and 5 days after nine weeks' storage at +3° F.

The procedure of hydrolyzing lactose by storage of the mix at 45° F. for 5 days is not recommended by the authors, because of increased acidity and reduction in the flavor score. It is suggested that the use of a higher temperature for a shorter period of time would be a more desirable procedure for hydrolyzing the lactose in ice cream or ice milk mixes. To avoid excessive sweetness resulting from the hydrolysis of lactose, the authors recommend a slight reduction in the added sucrose in such mixes. W. J. Caulfield

163. Problems of the soft serve operators (Part XVIII). Pest control. P. E. Paper. Ice Cream Rev., **40**, 5: 89. 1956.

In the current article the control of flies, termites, cockroaches, mice, and rats in soft-serve stores is discussed. The information given will prove equally valuable for any ice cream establishment. W. J. Caulfield

164. Method of packaging ice cream and container therefor. M. F. Afferbaugh. U. S. Patent 2,771,369. 1 claim. Nov. 20, 1956. Offic. Gaz. U. S. Pat. Office, **712**, 3: 572. 1956.

Ice cream having an overrun above that desired in t[illegible] finished package is filled into two open-end containers. The two open ends are placed opposite each other and the two containers pressed together, to compress the ice cream to the desired overrun. R. Whitaker

165. Apparatus for forming frozen confections. W. Sedutto. U. S. Patent 2,767,664. 5 claims. Oct. 23, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 4: 742. 1956.

A device is described for making a cavity in a frozen confection formed in a mold cup.
R. Whitaker

166. Combined frozen confection, cup, and pipette. E. E. Moubayed. U. S. Patent 2,766,123. 6 claims. Oct. 9, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 2: 347. 1956.

A frozen confection is described consisting of a cylindrically shaped portion mounted on a handle. The handle holds a cup and tube which penetrates the product. As the confection melts, the liquid collects in the cup. The end of the tube is exposed when the piece is about half-consumed and the melted portion can be sucked from the cup through a hole in the side of the tube at the bottom of the cup. A spiral groove directs the flow of melting confection. The whole is encased in a paper bag for protection during merchandising.
R. Whitaker

167. Method of confection of frozen comestibles. E. D. Fear (assignor to De-Raef Corp., Kansas City, Mo.). U. S. Patent 2,767,098. 7 claims. Oct. 16, 1956. Offic. Gaz. U. S. Pat. Office, **711**, 3: 596. 1956.

Mix for making ice cream and various frozen desserts is stabilized by standardizing the acidity to between 0.1 and 0.2%, and then introducing calcium sulphate into the mix, prior to freezing at the rate of 0.1 to 0.5%.
R. Whitaker

168. Confection coating apparatus. F. A. Landgraber (assignor to Drumstick, Inc., Fort Worth, Tex.). U. S. Patent 2,769,423. 10 claims. Nov. 6, 1956. Offic. Gaz. U. S. Pat. Office, **712**, 1: 74. 1956.

A machine is described for coating factory-filled ice cream cones with a layer of material upon which is dispersed chopped nuts, candy, or other granules. R. Whitaker

169. Multiple-drink mixing machine. L. A. Brown and J. E. Brotheridge (assignors to Prince Castle Mfg. Division, Inc., Sterling, Ill.). U. S. Patent 2,774,579. 6 claims. Dec. 18, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 3: 565. 1956.

A milk-shake machine has a series of mixers powered by a single motor but so arranged that they can be operated singly. R. Whitaker

170. Variegators. F. T. Moser (assignor to American Food Laboratories, Inc., Brooklyn, N. Y.). U. S. Patent 2,774,314. 16 claims. Dec. 18, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 3: 496. 1956.

A device is described for continuously distributing fruit, candy, nuts, syrup, and other flavoring materials in ice cream as it leaves a freezer. R. Whitaker

MILK AND CREAM

171. Ensilagekvalitetens indflydelse paa mejeriprodukternes kvalitet (The effect of silage quality on the quality of dairy products). J. L. Hermansen, E. O. Petersen, A. H. Pedersen, A. N. Fisker, and H. E. Birkkjaer, Govt. Research Inst. on Dairy Ind., Denmark. Bull. 101. 1956. (English Summary).

Milk from cows fed beet top or sugar beet waste silage of good and poor quality was shipped to the Institute from two creameries. The milk was examined bacteriologically and evaluated for its suitability for manufacture of fluid milk, butter, and cheese.

Feeding of silage of good quality resulted in milk less contaminated with bacteria. However, the total contents of bacteria of the two types of milk were of such magnitude that the differences in bacterial contents were considered insignificant.

The products made from milk from cows fed high quality silage were better than those made from milk from cows fed poor quality silage, but they were not considered to be of the finest grade. T. Kristoffersen

172. Fria fettsyror och lipasverkan i mjölk (Free fatty acids and lipase activity in milk). G. Sjöström and J. Willart, Alnarp. Svenska Mejeritidn, No. 32. 1956.

Anticipating the eventual introduction of pipeline milkers on Swedish farms, the authors have studied certain factors affecting lipase activity and free fatty acids in milk. Among the factors studied were: quality of milk, individual cows' milk, the intensity of the treatment of the milk, temperature, and pH. In addition, studies were conducted on the heat stability of the enzyme and the effect of separation on the distribution of free fatty acids.

Milk from individual producers contained from 0.11 to 0.84 meq. of C5 and higher fatty acids and from 0.003 to 0.014 meq. of butyric acids per 10 g. of butterfat.

Lipase activity was evident in milk which had been stored for 24 hours under laboratory conditions even as low as 4° C. Aeration of milk for 2½ hours at 20° C. resulted in approximately a 5-fold increase in fatty acids. Agitation of milk at 30° C. followed by a 24-hour period of rest, resulted in considerable increases in fatty acids. The increases were in proportion to the length of time of agitation.

More fatty acids were liberated at 30° C. than at 18 or 45° C. No lipase activity was evident at pH 4.6, but increasing activity was registered with increasing pH at pH levels of 5.7, 6.6, and 7.7. The last portion milked contained more lipase activity after activation by stirring than did the first portion. The enzyme was destroyed by pasteurization.

Separating experiments demonstrated that butyric acid followed the skimmilk. The water-soluble fatty acids above butyric followed the cream. T. Kristoffersen

173. Problemet "kontrollmjölk" (The problem of "certified milk"). T. Storgards, Stockholm. Svenska Mejeritidn, 51. 1955.

The belief held by many producers of certified milk that such milk is better suited for pasteurization than regular milk for market milk was disproven.

From a bacteriological point of view, pasteurized certified milk was superior. However, certified milk was found inferior flavorwise. Oxidized flavors developed, often after one day of storage. This defect did not occur in the ordinary pasteurized market milk.

T. Kristoffersen

174. Frozen milk—new market for milk product processors. D. Merlin. Milk Prod. J., **47**, 11: 14. 1956.

Frozen homogenized and frozen fortified skimmilk are being successfully marketed by a frozen food firm operating out of Midland, Michigan. About 50% of a total of 700 frozen food customers are being serviced with frozen milk as of July, 1956. The av. frozen food customer buys anywhere from 40 to 120 qts. of milk per delivery.

The success of this venture is attributed to quality and price. The flavor of this product has remained satisfactory for periods of 2 mo. Several experiments have shown the keeping time of frozen milk to be as long as six mo. The saving in price amounts to 4½ to 5¢ per qt. as compared to the retail price of fluid milk. The milk is packed in qt. cartons and frozen at a temperature of 0° F. within 24 hr.

Instructions are supplied on how to handle and defrost the frozen product. The frozen milk separates just slightly after thawing, but this is not considered as serious. Cost of freezing the milk is considered to be about ¼ to ½¢ per qt. J. J. Janzen

175. Air intake the key to rancidity. L. Jokay and J. M. Jensen, Mich. Agr. Exp. Sta., East Lansing. Milk Plant Monthly, **45**, 8: 22. 1956.

A study of pipeline installations at Mich. State Univ. showed that lines of 200 ft. in length with moderate riser heights may be used without causing significant increases in fatty acid degree or rancid flavor, provided air inlet and milk flow are properly regulated. The study also showed that excessive line slope should be avoided when risers are used. Vibration of lines during washing frequently causes joints to become loose, and air leaks occur. Irregular and especially high fatty acid degree values in milk samples at various points of sampling a line are indicative of air leaks.
C. J. Babcock

176. Higher tests from tank milk. M. F. Ellmore and J. B. Smathers, Va. Polytechnic Inst., Blacksburg. Milk Plant Monthly, **45**, 9: 33. 1956.

The DHIA test was used as a reference to measure the differences between can and bulk tests, in a study of milk from 43 herds located in Northern Virginia. The survey indicated that, on the average, the difference between the can and bulk tank tests made in the plant compared to the DHIA tests favor the bulk test by .06%. The same result was obtained by a gross comparison, a comparison when the data were arranged according to years and a comparison when the data were arranged according to season. The information is presented by graph and tables. C. J. Babcock

177. Detéction des laits reconstitués et choix d'un révélateur (Detection of reconstituted milk and choice of an indicator). V. Toubol. Le Lait, 36: 385. 1956.

The author proposes to add a product such as dried potatoes to animal food milk powder, to make it easy to determine whether or not this product is being reconstituted for use as human food. A. W. Rudnick, Jr.

178. Pouring-spout construction for paper containers. M. Coralline. U. S. Patent 2,775,373. 7 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 4: 761-762. 1957.

A carrier and holder for a Pure-pak type paper milk container with a pouring-spout in the top side of the container. R. Whitaker

179. Fluid milk dispenser. W. J. Tamminga (assignor to Monitor Process Corp., Jersey City, N. J.). U. S. Patent 2,775,374. 23 claims. Dec. 25, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 4: 762. 1957.

A valve is described for releasing milk into a glass from a bulk container, when the glass is pressed against a lever extending below the valve. R. Whitaker

180. Dispensing valve for a pressurized container. L. M. Collins and P. F. George (assignors to Pressure Dispensers, Inc., Beverly Hills, Calif.). U. S. Patent 2,772,035. 8 claims. Nov. 27, 1956. Offic. Gaz. U. S. Pat. Office, **712**, 4: 753. 1956.

A valve is described for releasing the contents of pressure-packed liquids, such as cream.
R. Whitaker

181. Lever type dispenser system for pressurized containers. A. E. Poarch and P. E. Harrison (assignors to Avoset Co., San Francisco, Calif.). U. S. Patent 2,772,819. 6 claims. Dec. 4, 1956. Offic. Gaz. U. S. Pat. Office, **713**, 1: 112. 1956.

A valve is described for use in releasing cream and similar liquids in a whipped condition from a pressure-packed can.
R. Whitaker

NUTRITIVE VALUE OF DAIRY PRODUCTS

182. Influence de l'ébullition domestique du lait sur son efficacité calcique (Influence of home boiling of milk on its calcium efficiency). D. Hugot and J. Causeret. Le Lait, 36: 487. 1956.

It was found by rat feeding experiments, that the boiling of pasteurized milk for five minutes had no appreciable effect on the coefficient of calcium retention. A. W. Rudnick, Jr.

183. Influence de l'ébullition domestique du lait sour son efficacité protéique (Influence of home boiling of milk on its protein efficiency). G. Reynaud and J. Causeret. Le Lait, 36: 369. 1956.

In feeding trials with rats, it is concluded that boiling pasteurized milk, even to forming a "skim," does not modify to any degree the digestive utilization or biological value of milk.
A. W. Rudnick, Jr.

SANITATION AND CLEANSING

184. Seek economical waste treatment. Anon. Milk Plant Monthly, **45**, 11: 13. 1956.

The DIC subcommittee on dairy waste urges that every plant adopt the following program: 1. Appreciation, recognition, and active participation on the part of company officials. 2. Education of plant personnel in waste-prevention measures through meetings, literature, and on-the-job instruction. 3. Proper selection, operation, and maintenance of equipment. The present status of research projects dealing with dairy-waste disposal are reviewed.
C. J. Babcock

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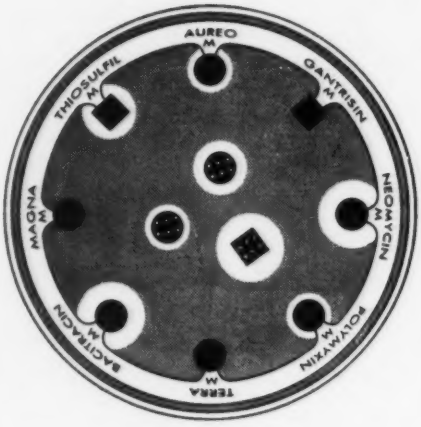
for FAST, ACCURATE, DEPENDABLE

Microbial Sensitivity Testing



BACTO
UNIDISK
and
BACTO
SENSITIVITY DISKS

10 or more susceptibility tests at one time

for 8 years the preferred reagents because . . .

25 ***agents*** for maximum choice of therapeutic agents
3 ***concentrations*** to give greatest selectivity
166 ***packagings*** for convenience
Precise readings without cross-reaction
Greatest economy
Accurately standardized

Bacto - Unidisks combine eight therapeutic agents in a single sterile device individually sealed in a plastic container to assure sterility. Bacto - Unidisks provide for ready identification by use of characteristic color as well as name of agent and its concentration.

Bacto - Sensitivity Disks are sterile, prepared in three concentrations of each agent; colored and marked for quick and accurate identification.

AVAILABLE ON REQUEST

Bulletin No. 152, describing Bacto - Unidisks
Bulletin No. 146, Microbial Sensitivity Testing
Report sheets for reporting Microbial Sensitivities

DIFCO LABORATORIES

DETROIT 1, MICHIGAN